# REVISED

# FOCUSSED FEASIBILITY STUDY

## TENNESSEE PRODUCTS SUPERFUND SITE

# CHATTANOOGA CREEK

## Chattanooga, Tennessee

**Prepared For:**

**UNITED STATES ENVIRONMENTAL PROTECTION AGENCY**
**Region IV**
**Atlanta, Georgia**

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**July 1999**

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# A. FFS EXECUTIVE SUMMARY

## 1. GENERAL

This Focussed Feasibility Study (FFS) report for the Tennessee Products Superfund Site, (a.k.a. Chattanooga Creek), was developed by the U.S. Army Corps of Engineers (USACE), Kansas City District, as a portion of an Interagency Agreement with the United States Environmental Protection Agency (USEPA) Region IV to provide technical assistance for the Remedial Investigation/Feasibility Study. This FFS report examines alternatives for the remediation of contaminated sediments and coal tar residues ("coal tar") in Chattanooga Creek. This FFS also examines the feasibility of leaving the sludges in the Creek and dealing with them in-situ. The FFS Executive Summary provides a concise overview of the contents and findings of the FFS report.

## 2. SITE DESCRIPTION

### a. Site Location

The Tennessee Products CERCLA Site (TPS), placed on the National Priorities List (NPL) in September 1995, is located in Chattanooga, Tennessee. The site, south of the downtown area, is defined as the portion of Chattanooga Creek near the communities of Alton Park and Piney Woods and can be found on the Chattanooga and Fort Oglethorpe 7.5' Quadrangles. The TPS consists of 2.5 miles of Chattanooga Creek and tar deposits in its floodplain. It encompasses the portion of Chattanooga Creek bounded to the north by the creek's confluence with Dobbs Branch and to the south at a point 65 feet upstream of the creek's intersection with Hamill Road Bridge.

### b. Site History

The Southern Coke Corporation, was one of several companies to operate a coal carbonization facility or coke plant located at 4800 Central Avenue. The plant property lies less than one mile west of Chattanooga Creek. This site was utilized as a coal carbonization facility from 1918 until 1987. It is believed that for a portion of this period, the facility maintained a private sewer line that discharged directly into the creek just upstream of Hamill Road bridge. Polynuclear aromatic hydrocarbon (PAH) contaminated discharge and/or runoff from the facility has also been documented in the northeast and northwest tributaries of the creek. Other companies located along the creek and in the vicinity also contributed PAH, pesticides, and inorganic contaminants to the creek. Coal tar deposits located in the flood plain of Chattanooga Creek and in the creek bed, are the result of many years of uncontrolled discharges.

### c. Extent of Contamination

The Chattanooga Creek Sediment Profile Study (April/August, 1992), produced by the EPA Environmental Services Division (ESD) as a result of the Chattanooga Creek Initiative, identified what was thought to be two distinct types of coal tar accumulations in the creek. One type of deposit exists as extensive reaches of sediments that are heavily contaminated (saturated) with coal tar, and contaminated with pesticides. These deposits were present for at least 11,900 feet of the stream bed from a point designated 1700 feet upstream of the intersection of the creek and 38th Street bridge to the point of the creeks confluence with the Dobbs Branch tributary. The second type of deposit existed primarily as large quantity mounds of coal tar in the creek bed and the flood plain of the creek. These deposits were thougt to be located in an area marked by the intersection of the creek and Hamill Road bridge to a point approximately 1800 feet downstream. A 1997-98 Early Removal Action revealed that large quantity mounds of coal tar were simply outcroppings of heavily contaminated sediments which was pervasive in the entire creek bed. The removal action excavated all coal tar contamination from a point 800 feet downstream of Hamill Road Bridge to a point 1350 feet downstream of the East 38th Street Bridge. The portion of the creek selected for the removal action posed an immediate threat to human health from direct contact because of its easy accessability. The estimated quantities of the remaining deposits and their location are as follows:

- FROM 64 ft U/S of Hamill Rd Bridge TO Hamill Rd Bridge. **(395 CY)**

- FROM Hamill Rd Bridge to 800 ft D/S of Hamill Rd Bridge (this was termed the "gray area" in the IT Removal Action Report). A quantity of 1420 CY was estimated from previous delineation and the excavation of October 1997 (assuming a 1-ft depth of coal tar below 2.5-ft of overburden and with a bedrock base) even though no coal tar was found during IT's June 1997 delineation. **(1420 CY)**

- FROM 1350 ft D/S of E. 38th St. Bridge (500 ft D/S of power line) TO Southern Wood Piedmont (this is D/S extent of additional delineation performed by IT). **(3667 CY)**

- FROM Southern Wood Piedmont TO confluence with Dobbs Branch **(8,700 CY)**. This is an extrapolation of the average volume of coal tar contaminated sediments estimated from the reach immediately upstream of this section (1.4 CY per foot length of channel).

### d. Nature of Contamination

The classes of compounds found in the stream are: polynuclear aromatic hydrocarbons (PAHs), chlorinated solvents, organic solvents, other chlorinated and related compounds (including pesticides and PCBs), metals, and phenols. The PAHs, other chlorinated compounds and phenols are from the semi-volatile group of compounds, while most of the organic and chlorinated solvents are volatile compounds. PAHs were found in every sample collected north of Hamill Road Bridge to Dobbs Branch, ranging from 810 ppb to greater than 20,000,000 ppb total PAH. Pesticides and PCBs were found in twenty-six out of thirty-two samples collected. The pesticides ranged in concentration from not detected (ND) to 51,000 ppb for Alpha-BHC near Hamill Bridge. PCBs ranged from ND to 12000 ppb in the sediment near Southern Wood Piedmont products. Volatile organic compounds (VOC) were found in only nine of thirty-two samples and ranged from ND to 1,760,000 ppb total VOCs near Hamill Road Bridge. All of these compounds are associated with the thick, black material found in the soil and sediments.

Many of the compounds found are typical coal tar constituents, while others are chemicals that mix readily with the coal tar and ash. Detected chlorinated compounds probably dissolved into the tars and were retained. The 1992 EPA Sediment Profile Study found low concentrations of pesticides and PCBs that had not been found previously. While pesticides and PCBs were found intermittently along the area of concern, the higher concentrations were invariably found in areas with high concentrations of coal tar. Hamill Road #1 Dump site was suggested as a possible source, as that site had reportedly contained more than just coal tar. The tributary which enters the creek near 39th street is also thought to have transported chemicals. This small stream passes by Velsicol's Residue Hill landfill, Velsicol Chemical Company, the Chattanooga Coke and Chemical facility and the former Reilly Tar facility (Reilly Industries, Inc.). Hardened pitch is likely to have encapsulated many solvents and other chemicals of concern.

The consistency of the material varies from hard asphalt-like material to a sludge. Experience with similar contaminants at creosote operations shows that the less viscous tars and sludges will migrate through sediments along opportunistic pathways, such as roots, sticks and other debris. This presents the possibility of contamination at several levels, with contamination moving from an upper layer to a lower sediment layer or radiating out along root paths.

In the 1992 EPA Sediment Profile Study, twenty-four different metals and low levels of cyanide were found in the sediment and surface water in the creek. Twenty-one metals and cyanide were found in the stretch of creek from

Hamill Road Bridge to Dobbs Branch, of these, sixteen metals were found twenty-two to thirty-two times out of thirty-two samples. Beryllium, selenium, and silver were found only three times out of thirty-two samples, and cadmium and sodium were detected only once each. Assessing frequency, concentration and the background values established in the study, several metals are above background. Specifically, aluminum, barium, chromium, copper, lead, magnesium, mercury, potassium and zinc are significantly above background levels. While metals are no doubt present as natural constituents of the sediments, elevated levels are indicative of contamination. Iron, while not significantly above background, is still a major analyte in the sediment. Metals will adsorb/desorb from normal sediments with changes in pH and the concentration of other metals in the immediate area. Iron, aluminum and manganese in particular will form colloids with other metals and will facilitate the transport of those metals.

## 3. SUMMARY OF REPORT

The Focussed Feasibility Study (FFS) report provides the site description and identification of the problem in Section B, brief description of human health and ecological risks in Section C, screening of technologies in Section D, detailed analysis of technologies in Section E, and a comparative analysis of Remediation Alternatives in Section F. The preliminary screening of technologies was performed and is summarized in Tables A-1 and A-2. The preliminary screening took into consideration the site contaminants and their current deposition in evaluating technologies in terms of effectiveness, implementability, and cost. The technologies included both in-situ and ex-situ options both for treatment and containment. Those with potential were retained for further consideration.

The number of technologies retained from the preliminary screening were still too numerous to carry on for detailed evaluation, therefore another phase of screening was performed. In this second phase, the technologies were evaluated in slightly more detail to identify problems that may eliminate them from further consideration. The second phase of screening is presented in Section D. It provides a brief description of each of the technologies retained as well as items that were considered in evaluating them for their potential effectiveness and implementability at this site. The discussion is broken down into in-situ, ex-situ and on-site and off-site treatment/disposal alternatives. The only in-situ option retained was a containment option. Ex-situ technologies retained include both containment and treatment alternatives. Table A-3 provides a summary of technologies retained after the second phase of screening. Technologies characterized as innovative where not retained for the detailed analysis due to lack the of data proving their effectiveness on the type and deposition of the contaminants found at this site.

The technologies retained from the second screening were carried on for the detailed analysis presented in Section E. The detailed analysis evaluates each of the options against seven of the nine criteria shown in Table A-4. The remaining two criteria, State Acceptance and Community Acceptance, will be addressed during the future remedy selection process.

Finally, Section F summarizes the alternative evaluation and ranks each of the alternatives performance against each of the criteria.

**TABLE A-1: PRELIMINARY SCREENING OF IN-SITU TREATMENT TECHNOLOGIES**

| **OPTION** | | **EFFECTIVENESS** | **IMPLEMENTATION** | **INNOVATIVE** | **RETAINED** |
|---|---|---|---|---|---|
| **BIOLOGICAL** | INTRINSIC BIODEGRADATION | NO | NO | YES | NO |
| | BIOVENTING | NO | NO | YES | NO |
| **PHYSICAL** | STABILIZATION | NO | NO | NO | NO |
| | SOIL VAPOR EXTRACTION | NO | NO | YES | NO |
| | SOIL FLUSHING | NO | NO | YES | NO |
| | NATURAL ATTENUATION | NO | NO | YES | NO |
| | RE-ROUTING AND CONTAINMENT | YES (?) | YES (?) | NO | YES (?) |
| **THERMAL** | VITRIFICATION | NO | NO | YES | NO |

(?) - indicates uncertainty in effectiveness or implementation

TABLE A-2: PRELIMINARY SCREENING OF EX-SITU TREATMENT TECHNOLOGIES

| TREATMENT TECHNOLOGIES | | EFFECTIVENESS | IMPLEMENTATIO N | COST | RETAINED |
|---|---|---|---|---|---|
| **CONTAINMENT OPTIONS** | | | | | |
| **PHYSICAL** | ON-SITE LANDFILL | YES | YES | M | YES |
| | OFF-SITE LANDFILL | YES | YES | M-H | YES |
| **TREATMENT OPTIONS** | | | | | |
| **BIOLOGICA** | BIOSLURRY | YES (?) | YES | M-H | YES |
| | LAND FARMING | NO (?) | NO | M | NO |
| | FUNGAL TREATMENT | NO (?) | NO | M-H | NO |
| | COMPOSTING | YES (?) | YES | M-H | YES |
| **PHYSICAL** | SOIL WASHING | NO (?) | YES (?) | H | NO[1] |
| | STABILIZATION | YES (?) | YES | H | YES (?) |
| | RECYCLING (Coal | YES (?) | YES (?) | M-H | YES (?) |
| | WASTE-TO-FUEL | YES | YES | M-H | YES |
| **CHEMICAL** | SOLVENT EXTRACTION | YES (?) | YES | H | YES[1] |
| | CHEMICAL REDUCTION | YES | YES | H | YES |
| | CHEMICAL OXIDATION | NO | YES (?) | H | NO[1] |
| | PYROLYSIS | YES | NO (?) | H | NO |
| **THERMAL** | ON-SITE | YES | YES | H | YES |
| | OFF-SITE TREATMENT | YES | YES | H | YES |
| | THERMAL DESORPTION | YES | YES | H | YES |
| | VITRIFICATION | YES | NO | H | NO |

1 - These options may be useful as part of a treatment process but not stand alone processes
(?) - indicates uncertainty in effectiveness or implementation
H - indicates high cost
M - indicates medium cost
L - indicates low cost

**TABLE A-3: REMEDIATION OPTIONS RETAINED FOR DETAILED EVALUATION***

| TECHNOLOGY | DEMONSTRATED RELIABILITY | GENERAL DATA NEEDS |
|---|---|---|
| RE-ROUTING AND ENCAPSULATION | Encapsulation - full-scale for a variety of soils and sediments (Solidification/stabilization) | Encapsulation - Bench-scale tests to determine proper applications, effectiveness and costs |
| ON-SITE LANDFILL | Implemented at many sites for many contaminants, a containment option - long-term controls required, potential for solidification prior to landfilling | Further information on costs, geotechnical characteristics of the site |
| ON-SITE THERMAL DESORPTION | Pilot-scale demonstrations for coal tar (PAH's), full-scale for other contaminants | Bench-scale tests to determine proper applications, effectiveness and costs |
| ON-SITE INCINERATION | Full-scale for PAH's in soils and sediments | Bench-scale tests to determine proper applications, effectiveness and costs |
| OFF-SITE WASTE-TO-FUEL | Full-scale for PAH's in soils and sediments | Bench-scale tests and waste analysis to determine , applicability and costs |

**TABLE A-4: CRITERIA USED IN ANALYSIS OF REMEDIAL ALTERNATIVES**

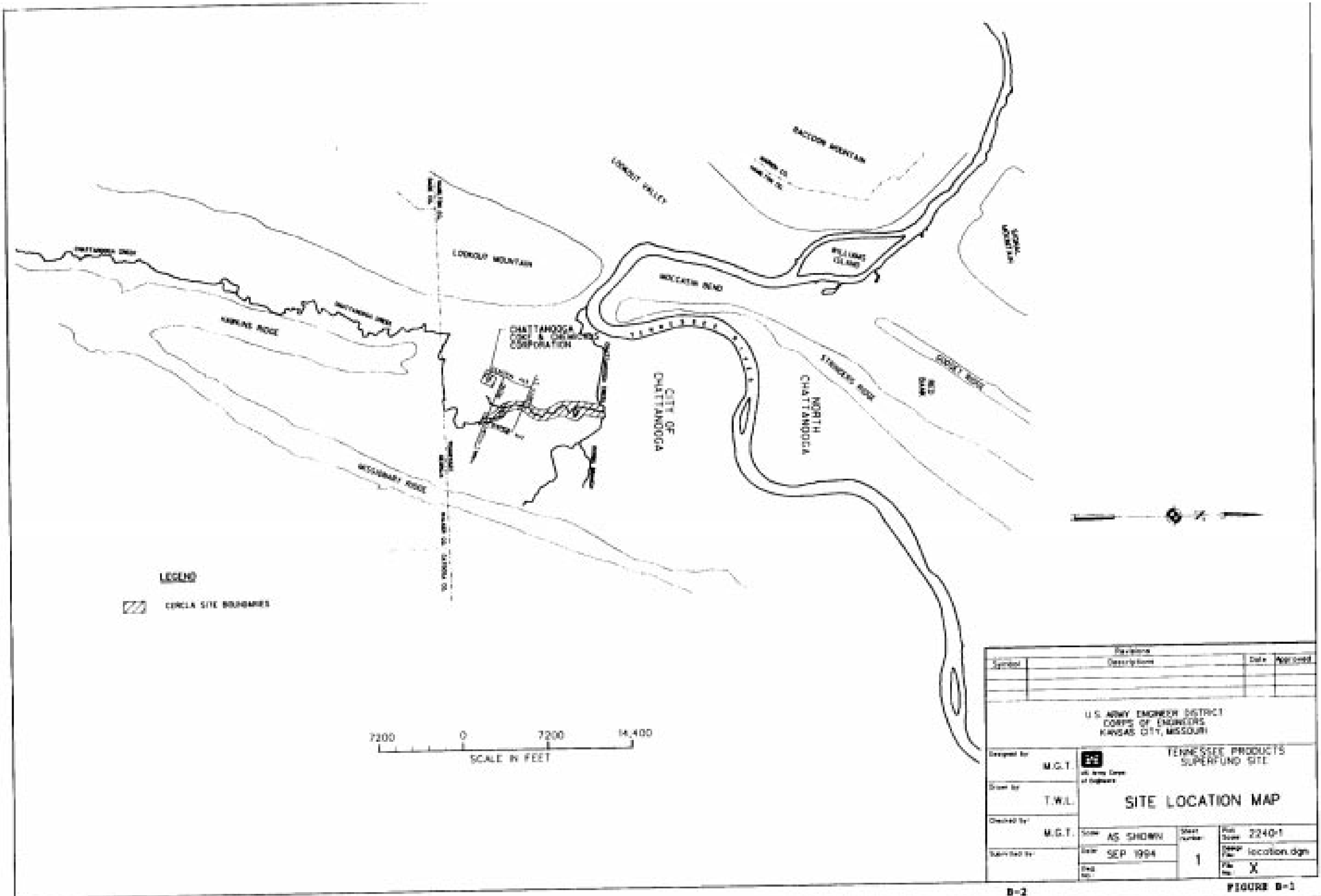
| SCREENING CRITERIA | EVALUATION CRITERIA | ROLE OF CRITERIA DURING REMEDY SELECTION |
|---|---|---|
| Effectiveness | Overall protection of human health and the environment | "Threshold" Factors |
| | Compliance with ARARs | |
| | Long-term effectiveness and permanence | "Primary Balancing" Factors |
| | Reductions in toxicity, mobility and volume through treatment | |
| | Short-term effectiveness | |
| Implementability | Implementability | |
| Cost | Cost | |
| | State acceptance | "Modifying" Considerations |
| | Community acceptance | |

## 4. CONCLUSIONS/RECOMMENDATIONS:

The comparison of alternatives summarizes the relative strengths and weaknesses of each alternative in relation to the evaluation criteria. It also provides a ranking of each of the alternative's performance against each of the criteria. Based upon this analysis, three alternatives stand out in terms of their performance against the criteria. They are On-Site Incineration, On-Site Thermal Desorption, and Off-Site Waste-To-Fuel. Although the two modifying criteria, "State Acceptance" and Community Acceptance" were not evaluated, it is anticipated that the Off-Site Waste-To-Fuel alternative would be favored. This alternative provides the same level of protection as the On-Site Treatment alternatives but in addition eliminates the potential annoyances of on-site treatment and achieves a beneficial re-use of the material. Furthermore, the Off-Site Waste-To-Fuel alternative was estimated to have the lowest cost of these three high ranking alternatives. The reliability of this cost data is estimated to be high due to the recent removal action performed at the site.

Some uncertainty exists whether all sediments, particularly those downstream of Southern Wood Piedmont, will have sufficient BTU value to meet criteria for the Waste-To-Fuel alternative. If a small quantity of sediments fall into this category, blending with more highly contaminated sediments may provide adequate feed for the Waste-To-Fuel alternative. If a large quantity of sediments fall into this category, On-Site Thermal Desorption is the preferred alternative for the non-criteria sediments.

Therefore, it is recommended that the Off-Site Waste-To-Fuel alternative be selected as the preferred alternative with On-Site Thermal Desorption considered as a contingency alternative for sediments not meeting Waste-To-Fuel criteria.


LOOKOUT VALLEY
RACCOON MOUNTAIN
SIGNAL MOUNTAIN
LOOKOUT MOUNTAIN
MOCCASIN BEND
WILLIAMS ISLAND
STRINGERS RIDGE
RED BANK
CHATTANOOGA CREEK
HAWKINS RIDGE
MISSIONARY RIDGE
CHATTANOOGA COKE & CHEMICAL CORPORATION
CITY OF CHATTANOOGA
NORTH CHATTANOOGA
LEGEND
CERCLA SITE BOUNDARIES
7200 0 7200 14,400
SCALE IN FEET
Revisions
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Descriptions
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Approved
U.S. ARMY ENGINEER DISTRICT
CORPS OF ENGINEERS
KANSAS CITY, MISSOURI
Designed by: M.G.T.
Drawn by: T.W.L.
Checked by: M.G.T.
Submitted by:
TENNESSEE PRODUCTS
SUPERFUND SITE
SITE LOCATION MAP
Scale: AS SHOWN
Date: SEP 1994
Sheet number: 1
7240-1
location.dgn
X
B-2
FIGURE B-1

is believed that the TPC facility maintained a private sewer line that discharged directly to Chattanooga Creek (here after referred to as "the creek") 1 1/8 miles from the plant. This sewer has been documented to exist in the year 1944 and appears on a diagram of the plant from 1967. The sewer was constructed and used by the Chattanooga Coke and Gas Company and TPC which date its existence to at least 1926. The sewer line terminated at the creek just upstream of the Hamill Road Bridge. The sewer line was abandoned at an unknown time. Polynuclear aromatic hydrocarbon (PAH) contaminated discharge and/or runoff from the facility has been documented in the northeast and northwest tributaries of the creek from 1977 until 1990. These tributaries flow from the coke plant and discharge to the creek 1800 feet downstream of the creek's intersection with Hamill Road bridge. Additionally, the facility allegedly utilized abandoned water supply wells for injection of wastes from a light oil washer column sometime in the late 1960's and early 1970's.

Coal tar deposits located in the flood plain of Chattanooga Creek and in the creek bed, is believed to be the result of many years of uncontrolled discharges of PAH containing wastewater and coal tar residues. The Chattanooga Creek Sediment Profile Study (April/August, 1992), produced by the EPA Environmental Services Division (ESD) as a result of the Chattanooga Creek Initiative, identified two distinct types of coal tar accumulations in the creek. This study also concluded that coal tar related materials have not been dumped, nor are they leaching, into the creek upstream of a point designated 2000 feet upstream of the intersection of the creek and Hamill Road Bridge.

The Sediment Profile Study identified two types of coal tar deposits. One type of deposit exists as extensive reaches of sediments that are heavily contaminated (saturated) with coal tar. Prior to the 1997-98 Removal Action, these deposits were present for at least 11,900 feet of the stream bed from a point designated 1700 feet upstream (south) of the intersection of the creek and 38th Street bridge to the point of the creek's confluence with the Dobbs Branch tributary. Subsequent to the removal action, these deposits currently exist at a point starting 1350 feet downstream of the East 38th Street Bridge and extending to the creeks confluence with Dobbs Branch.

The second type of coal tar deposit existed primarily as a large mass of concentrated coal tar waste in the creek bed and in two locations in the flood plain of the creek. These deposits were located in an area marked by the intersection of the creek and Hamill Road bridge to a point of overlap with the above deposits approximately 1800 feet downstream (North) of this intersection. Four large distinct deposits of coal tar waste containing high levels of PAHs were located in this reach of the creek bed. These deposits were found to be as deep as 12 feet. These deposits were largely removed during the 1997-98 removal action. Similar deposits potentially remain from a point 65 feet upstream of Hamill Road Bridge to 800 feet downstream of Hamill Road Bridge, although it is estimated that the depth is significantly less than that encountered in the removal action.

Two coal tar deposits were discovered in the floodplain of the creek. One deposit is located west of the present creek channel between Hamill Road and 38th Street in or near an old creek meander. The other deposit is located east of the Northeast Tributary and North of Hamill Road, in the floodplain of the creek. Both deposits contain significant levels of PAHs. These two deposits were remediated as part of the 1997-98 removal action.

The general location of the Site is demarcated by Dobbs Branch to the north, Hamill-Hooker Road to the south, Jerome Avenue to the east and the Alton Park neighborhood to the west. The coal carbonization facility is located south of Hamill-Hookers Road, north of Velsicol Chemical Corporation, east of Central Avenue, and west of Wilson Road.

**d. Physiography**

TPS lies near the boundary of the Valley and Ridge and Appalachian Plateau Physiographic Provinces, but is actually in the former. The Valley and Ridge Province extends as a narrow belt of folded strata from central Alabama to the Adirondacks in upstate New York. It is characterized by topography resulting from differential erosion of base-leveled folds. Near Chattanooga, the southern section of this province is dominated by slightly larger valley floors, less relief and southeast dipping beds which are a result of thrust faulting of most folds. The Appalachian Plateau Province is divided into several sections which also trend northeast-southwest. The Cumberland Plateau section is directly west of Chattanooga. It is underlain by rocks of Pennsylvanian age which are generally more resistant than those outcropping on the Allegheny Plateau section to the north. An undulating surface, submaturely dissected by young valleys, is characteristic of this section of the province. Lookout Mountain, which dominates the city's skyline, is part of the Cumberland Plateau as defined by the younger Mississippian and Pennsylvanian aged caprock. At the site, along the valley floor, surface elevations range from 660 to 640 feet above mean sea level.

**e. Soils**

The study area lies entirely within the floodplain of Chattanooga Creek. Therefore, soils are comprised entirely of alluvial deposits in both the creek bed and along the terraces. Soils in the upstream portion of the site consist primarily of Tupelo silty loam (USDA 1982). The Tupelo, according to the Soil Conservation Service (SCS), is characteristically a deep, somewhat poorly drained soil which rarely has slopes greater than three percent. Typically, the surface layer is a yellowish brown silty loam approximately eight inches thick. The subsoil generally extends to a depth of approximately 48 inches. The upper part of the subsoil is also a yellowish brown silty loam with mottled brownish grey clay. Beneath that is grey clay to a depth of five feet. The soil is low in natural fertility and organic content. It ranges from slightly to strongly acidic. Permeability is low and the available water content is moderate. The clayey subsoil restricts the movement of air and water and the growth of extensive root systems.

Downstream of the Tupelo soils, north of the 38th Street Bridge, the soils grade into the Newark Series. They also are poorly drained, nearly level soils commonly found in flood plains and depressions. Slopes range up to 3 percent, but commonly are less than 2 percent. The Newark's surface layer is typically a dark grayish brown silt loam about six inches thick. The subsoil is generally about 2 1/2 feet thick and in its upper part is a mottled brown to grayish-brown silty loam. The lower part of the subsoil is a gray silty loam. Newark soils are moderately fertile and contain a fair amount of organic matter. They are slightly acidic to mildly alkaline. The available water capacity in the pore spaces is high, permeability is moderate and runoff is slow.

Near the creek's confluence with Dobbs Branch, the SCS classifies the soils into the Colbert-Urban Land Complex Series. This unit consists of deep, moderately well-drained, gently sloping Colbert soils, urban land, and disturbed areas as a result of construction activities. This unit can occasionally be found further upstream within the Tupelo and Newark soil units. Near Dobbs Branch, Colbert soils make up 25 to 45 percent of the land surface, urban development approximately 25 to 45 percent and disturbed areas about 10 to 25 percent. Typically, Colbert soils have a surface layer of brown silt loam four inches thick. The subsoil is a yellowish-brown clay that is mottled in its lower part. It is generally about four feet thick. Limestone bedrock can often be found at depths less than ten feet in this area. Colbert soils are low in natural fertility and organic content. They are slightly to strongly acidic, except in the layers just above bedrock. These soils are mildly alkaline. Permeability is very low and the available water capacity is moderate. The shrink-swell potential is high and the soils are poorly suited for most construction purposes. The disturbed areas have been excavated during installation of utilities and cut and filled during grading operations. They are altered to the extent that individual soils cannot be identified nor judgements made about their suitability for specific uses.

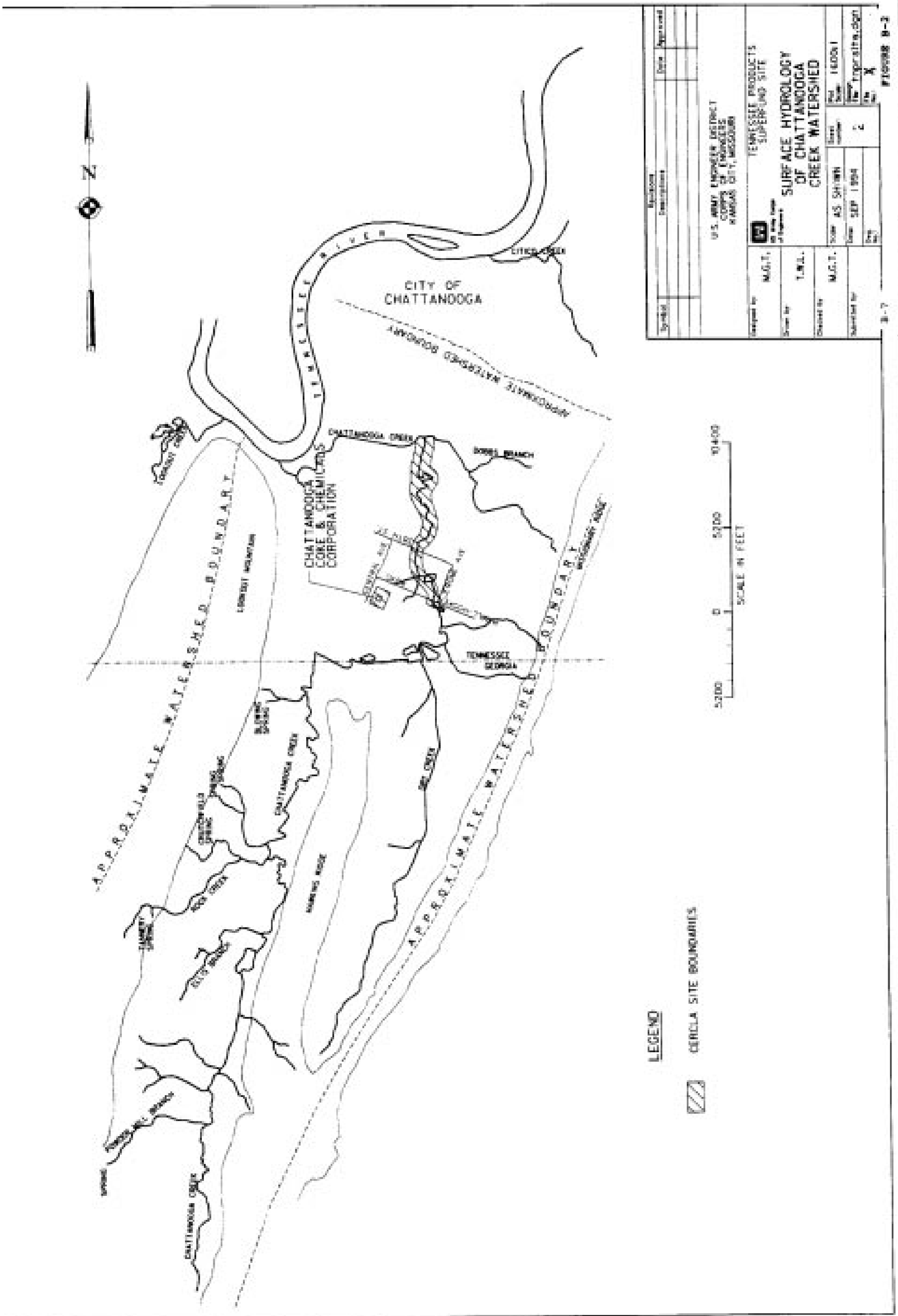
**f. Surface Hydrology**

Chattanooga Creek forms in Georgia, flows northward into Tennessee and eventually into the Tennessee River just downstream of downtown Chattanooga, and above Nickajack Reservoir. Nickajack Lake is the result of the Tennessee Valley Authority constructing a hydroelectric dam at river mile 425. The creek is a gaining stream throughout its course and in its Georgia headwaters is fed by several springs. Some of the more notable springs feeding it are Powder Mill, Tannery, Crutchfield and Blowing. Except for Dobbs Branch, three miles upstream from the mouth, the majority of contributing tributaries also enter the creek's base flow in Georgia. A few of the bigger streams, moving from the headwaters are Powder Mill Branch, Ellis Branch, Rock Creek and Dry Creek. The creek has a watershed of nearly 75 square miles, of which approximately twenty percent is in Tennessee. It occupies the northern portion of the Chattanooga Valley between Lookout Mountain and Missionary Ridge. The surface hydrology of the Chattanooga Creek watershed is presented in Figure B-2.

**g. Meteorology**

General: Chattanooga Creek is in the Tennessee River basin, which is regulated by a series of dams along the river and large tributary dams in the headwaters. The topography of the surrounding area of Chattanooga Creek is rough and mountainous, promoting a special susceptibility of the stream to overflow due to heavy, short duration, spring and summer storms. The climate of the area is generally mild. The average annual temperature is 59.7 degrees fahrenheit, the average annual precipitation is 52.6 inches, and the average annual number of frost- free days is 215.

Principal Flood Problems: Other than the Tennessee River, Floodplain development is considered to be heavily developed in the Chattanooga Creek basin. Backwater from severe Tennessee River floods could extend up the entire length of Chattanooga Creek. Headwater flooding prevails along Chattanooga Creek but has not been a major problem. In the past, Tennessee River backwater has caused heavy flood damage to the highly developed floodplain.


N
CITY OF CHATTANOOGA
TENNESSEE RIVER
APPROXIMATE WATERSHED BOUNDARY
CHATTANOOGA CREEK
DOBBS BRANCH
CHATTANOOGA COKE & CHEMICALS CORPORATION
LOOKOUT MOUNTAIN
TENNESSEE
GEORGIA
MISSIONARY RIDGE
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SCALE IN FEET
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CERCLA SITE BOUNDARIES
U.S. ARMY ENGINEER DISTRICT
CORPS OF ENGINEERS
KANSAS CITY, MISSOURI
TENNESSEE PRODUCTS
SUPERFUND SITE
SURFACE HYDROLOGY
OF CHATTANOOGA
CREEK WATERSHED
AS SHOWN
SEP 1994
FIGURE B-2

### h. General Geology

Within Hamilton County, rock outcrops range in age from Early Cambrian to Pennsylvanian. In general, rocks of the older Cambrian strata are confined to the eastern two-thirds of the county in the Valley and Ridge province (Wilson, 1979). The western portion of the county, including the caprock of Lookout, Raccoon and Signal Mountains, has younger Mississippian and Pennsylvanian rocks exposed. At the western edge of the Valley and Ridge, the middle part of the county is underlain by rocks of the Knox Group and Chickamauga Supergroup. The Knox Group is the single most abundant stratigraphic unit in the county. It has a mapped thickness of about 2600 feet. It underlies approximately 30 percent of the county's surface area.

Structurally, the county lies across a broad, regionally extensive, faulted anticlinorium bounded on the east by the Whiteoak Mountain synclinorium and on the west by the Walden Ridge syncline (Milici, 1979). The Allegheny structural front crosses Hamilton County in a northeasterly direction, generally following the trace of the Cranmore Cove fault. To the west of this front, within the Cumberland Plateau Physiographic Province, structures are within the Appalachian Foreland Thrust structural province. Around Chattanooga the ridges in the Valley and Ridge consist primarily of older Cambrian and Ordovician limestones and dolomites. Younger Pennsylvanian and Mississippian strata characteristically dominate the caprock on the plateau.

### i. Site Geology

Underlying approximately 5 to 20 feet of alluvial deposits along the creek are Cambrian and Ordovician limestones and dolomites. A thrust fault, the Chattanooga Fault, runs roughly parallel to the creek from the state line to the confluence with Dobbs Branch. The upthrown rocks on the east side of this thrust fault are of the Knox Group. At some locations within Hamilton county the Knox Group is divided into four formations (the Copper Ridge Dolomite, Chepultepec Dolomite, Kingsport Dolomite and Mascot Dolomite), however, near the site, the Knox Group is undifferentiated (Finlayson, et al, 1964 and Milici, et al, 1978). It is a very siliceous dolomite which is light to dark grey, fine- to coarse-grained and thin- to very thick-bedded. It weathers to a cherty rubble. A grey, fine-grained limestone is occasionally found in the upper part of the unit.

Rocks of the Chickamauga Super Group lie on the west side of the Chattanooga Fault. Like the Knox Group, in the vicinity of the site these rocks are undifferentiated. Elsewhere, the Chickamauga is frequently divided into the

# TENNESSEE PRODUCTS SITE
# GENERALIZED STRATIGRAPHIC COLUMN

| SYSTEM | SUPERGROUP | GROUP OR SERIES | FORMATION | THICKNESS | LITHOLOGY | GENERAL DESCRIPTION |
|---|---|---|---|---|---|---|
| QUATERNARY | | RECENT | | 5'-15' | | ALLUVIUM - sand and gravel underlain by clay |
| ORDOVICIAN | CHICKAMAUGA | | UPPER | 500' | | LIMESTONE - light grey to grey, fine- to medium-grained, thin- to medium-bedded, minor chert |
| ORDOVICIAN | CHICKAMAUGA | | LOWER | 1000' | | LIMESTONE - light grey to grey, fine to coarse-grained, thin- to thick-bedded, minor dark blocky chert, approximately four feet of bentonite at top |
| ORDOVICIAN / CAMBRIAN | | KNOX | UNDIFFERENTIATED | 2600' | | DOLOMITE - siliceous, light to dark grey, fine- to coarse-grained, thin- to very thick-bedded, weathers to cherty rubble, minor grey, fine-grained limestone in upper part |

(from Finlayson, et al, 1964)



FIGURE B-3

Stones River and Nashville Groups, and then into formations (Pond Spring, Murfreesboro, Ridley, Jewell Bluff, Lebanon, Carters, Hermitage, Cannon and Catheys Formations). Finlayson, et al, do however, divide the Chickamauga Super Group into an upper and lower unit. The upper unit, which has been mapped on the west side of the thrust fault near the site, is about 500 feet thick. It is a light gray to gray, fine- to medium-grained limestone with a very minor amount of chert. The upper part of the Chickamauga is thin- to medium-bedded. A generalized stratigraphic column of rocks in the site's vicinity is included as Figure B-3.

**j. Previous Site Characterization Studies**

During the 1970's the Tennessee Division of Water Quality Control (TDWQC) made much progress in issuing NPDES permits to companies, thus bringing industrial discharges entering the creek under some environmental control.

In 1973 and 1977, the EPA conducted a number of studies in the area, including two which focused on Chattanooga Creek. The early studies centered on water quality, and did not address the creek sediment. The major sources of contamination were identified, and the wastewater discharges, as well as Chattanooga Creek surface water, were characterized. These early studies included analyses of water for organic compounds.

In 1980, the Tennessee Valley Authority (TVA) conducted a special survey for toxic priority pollutants which included sediment samples. The findings indicated that much of the creek sediment was contaminated. During this period an agreement was reached between EPA and Velsicol Chemical Company to prevent the migration of site contaminants from the area known as "Residue Hill." This area, located south of the TPS site, contained chemical residue and was producing leachate. The hill was capped and a leachate collection system installed in an attempt to stabilize the site. The discovery of toxic materials in the creek during the TVA study and the completion of the Velsicol project highlighted the need for further data to adequately characterize the creek's water quality, contaminant concentrations in the sediment and aquatic biota. In order to address these data gaps, an aquatic life study was conducted by TDWQC during June 1981; EPA, TVA and TDWQC performed a sediment study of the creek during 1981 and a water quality study was done by TDWQC in July 1982. Results of these studies showed that the worst contamination in the creek occurred between creek mile (cm) 5.06 and cm 2.10. This stretch of creek included the Hamill Road Dump #1 (HRD1) site which contained a wide variety of organic compounds. Within this reach also lies the tributary that for many years served as a conduit for Velsicol Chemical, Reilly Tar (Reilly Industries, Inc.), and Chattanooga Coke Corporation wastewater discharges into the creek. A large deposit of PAHs was detected near cm 4.47 at the confluence of the creek and this tributary.

During 1990, a water quality and sediment study was completed by Dynamac Corporation for EPA on the creek. Additionally, RCRA 3007 information request letters were sent to all facilities located along the creek. Responses to these letters provided some information regarding potential sources of contamination from these industries. Results of the sediment study indicated that the areas previously identified during the 1980s were still contaminated to the same relative degree. It also concluded that PAHs were the most abundant compounds detected, and that general water quality above Dobbs Branch had slightly improved. The improvement can probably be attributed to elimination of wastewater discharges to the creek, remediation of HRD1 and HRD3, partial remediation of the Southern Wood Piedmont site and the installation of an infiltration collection system at the 38th Street Dump. Comparisons of the 1980 and 1990 studies show that contaminant concentrations and stream conditions below Dobbs Branch had not changed.

In mid-1992 the Environmental Services Division (ESD) of the EPA, EPA contractors and the Tennessee Department of Environment and Conservation (TNDEC) collected sediment samples from the state line to the creek's mouth. Following data collection, the EPA prepared the Chattanooga Creek Sediment Profile Study Report. The field effort was divided into two phases. Phase I consisted of collecting sixty sediment/soil samples, thirteen water samples and one waste sample. This initial phase of the study indicated that the lower reaches of the creek bed, from the Hamill Road Bridge downstream, are naturally underlain with a heavy clay deposit. The sampling also indicated that creek sediments along the entire length of the site are contaminated with coal tar derivatives. Less ubiquitous, and often associated with the mound deposits near the Hamill Road Bridge, are other VOCs indicative of chemical manufacturing/processing. Other contaminants of concern sporadically found on-site are BTEX compounds (Benzene, Toluene, Ethylbenzene, and Xylenes), pesticides, PCBs and metals (Chromium, Mercury, Lead and Barium). Water samples infrequently exhibited contamination and were shown to be nearly as clean as the control sample upstream of the heavily industrialized section of the creek.

Phase II of the survey delineated and quantified the coal tar contaminated creek sediments from Hamill Road Bridge to Dobbs Branch. During this field effort cross-sections were set up at intervals along this reach and core samples were taken down to natural alluvial materials. This enabled the EPA to get a profile of the creek bed and extrapolate volumes of material which needed to be removed. The estimate derived from these studies predicted that 14,500 cubic yards of material will need to be removed.

In 1993, the Agency for Toxic Substances and Disease Registry (ATSDR) issued a Public Health Advisory for Chattanooga Creek. The Health Advisory concluded that "the presence of the coal tar in and around the creek poses a health and safety hazard." Because of unrestricted access to a portion of the creek, people could be exposed to site-related contaminants through ingestion and dermal contact. The coal tar deposits are also physical hazards to adults and children that wander into these areas. ATSDR's recommendations were: dissociate nearby residents from the coal tar deposits; continue site characterization studies of the site; consider the site for inclusion on the National Priorities List and use appropriate EPA statutory or regulatory authority to take necessary actions; and, consider other coal tar contaminated sites along Chattanooga Creek for inclusion on the NPL. Based on this Health Advisory, EPA initiated a non-time critical removal of the most accessible coal tar deposits along Chattanooga Creek and at the former Southern Coke and Chemical plant site. In 1996 EPA issued an Engineering Evaluation/Cost Analysis for the removal action, which was consistent with a planned long term remedial action strategy. On September 26, 1996, EPA issued an Action Memorandum approving the proposed non-time critical removal action as described in the EE/CA. After commencing the removal action, EPA recognized that volume of coal tar, as estimated in the EE/CA, was too low. Consequently, on September 24, 1997 and August 5, 1998, EPA issued two additional Action Memoranda authorizing the expenditure of additional amounts to address the actual volume of coal tar in the Creek.

In June/July of 1997, IT Corporation performed a delineation of coal tar deposits in the creek. The purpose of the delineation was to determine the distribution and quantities of coal tar in the creek for the upcoming removal action. The delineation occurred along a 5,800 foot section of creek, starting at Hamill Road Bridge and ending at 1300 feet downstream of the E. 38th Street Bridge, in the vicinity of Alton Park Junior High School.

In March/April of 1998, IT Corporation performed a coal tar delineation of the creek sediments starting approximately 1350 feet downstream or the E. 38th Street Bridge to the property line of Southern Wood Piedmont Company. This comprised an approximately 2,600 foot reach of the creek.

On May 18th, 1998 IT Corporation completed a delineation of coal tar delineation of the creek sediments upstream of Hamill Road Bridge. The reach delineated extended from 100 feet upstream of the Hamill Road Bridge to the

Hamill Road Bridge.  The results of the delineation are outlined in the Section 3b, Extent of Contamination.

**k. Natural Resources**

Sensitive and Unusual Habitats or Ecosystems. The riparian and wetland habitat/ecosystem of Chattanooga Creek forms an important greenway through the city of Chattanooga.  Even with its problems, this stream is particularly valuable for overwintering migratory waterfowl.  The many functions and values associated with the wetlands of Chattanooga Creek are valuable in this urban setting due to the extensive industrial and metropolitan development.

Aquatic Habitat.  Aquatic habitat in the project area includes Chattanooga Creek and its associated oxbows, beaver ponds, excavated borrow pits and riparian forested areas that are seasonally flooded.  Chattanooga Creek possesses a fairly diverse habitat which includes logs, snags, bank overhangs, pools and riffles located upstream of the 38th street bridge.  Below the 38th Street Bridge, and especially from Dobbs Branch downstream, the creek has less habitat diversity where channelization has occurred. Additionally, the waters exhibit low dissolved oxygen and can be anaerobic due to the biological oxygen demand from the sewage and wastes carried by the numerous storm sewers and outfalls that empty into this reach.  Here the main stream channel is the primary habitat type and there are few snags, no riffles and no bank overhangs.  Also, the stream flow is diminished and the substrate has changed from the rubble, gravel and coarse sand substrate that is visible in the upstream reaches.  The creek bed is characterized by a silty and organic laden substrate in the downstream reaches below 38th street.  Substrate is an important factor in determining the composition of the macroinvertebrate fauna since the coarser substrates are preferred by benthic fauna.  Silts not only impact the fish community by elimination of spawning areas, but also by decreasing their food supply of benthic macroinvertebrates.  Chattanooga Creek is classified for "Fish and Aquatic life" from its mouth to the State line. Under water quality criteria rules for the Tennessee Department of Environment and Conservation (September 1991), for the "Fish and Aquatic Life" classification, "bottom deposits or sludge banks of such size or character that may be detrimental to fish and aquatic life" are prohibited.  It is evident from biological studies that disruption of the fauna has occurred and is continuing to occur in the lower reaches of Chattanooga Creek and that the impacts have affected the balance of the aquatic community and retarded the attainment of a viable fish and aquatic community.

Water Quality  The waters of Chattanooga Creek have been polluted for many years; this was recognized as early as 1937.  The pollution primarily stems from raw sewage overflows containing fecal coliforms of over 1000 coliforms per liter, industrial releases, chemical pollutants from waste dumps, and non-point sources of urban pollutants. The implementation of Federal and Tennessee Department of Health and Environment (now Tennessee Department of Environment and Conservation) National Pollution Discharge Elimination System (NPDES) permits during the 1970s and 80s, opened an era for significant water quality improvement in the creek. NPDES permits issued by the Tennessee Division of Water Quality (TDWQC) during the 1970s brought industrial discharges entering the creek under some environmental control. Other measures, such as remediation of Hamill Road Dumps sites #1 and #3, partial remediation of the Southern Wood Piedmont site and installation of an infiltration collection system at the 38th Street Dump have also contributed to the general improvement to the waste contaminant concentrations in the stream. Although the FFS study area of Chattanooga Creek is located in an urban/industrial area, the creek is classified for "Fish and Aquatic Life" from the Tennessee river to the Tennessee/Georgia border. The water quality does not currently meet the standards for this classification. The primary factors preventing attainment are the coal tar deposits, contaminated sediments, and sewer discharges.

Wetland Habitat. A wetland inventory and classification was conducted by the Environmental Protection Agency in 1992 on Tennessee the portion of the Chattanooga Creek basin. The wetlands were inventoried and classified according to vegetation, hydrology and soil type. This field survey characterized and mapped the jurisdictional wetlands associated with the lower reaches of Chattanooga Creek.

The results of this inventory are depicted on the wetlands inventory map (Figure B-4). It should be noted that this preliminary map is for planning purposes and does not constitute the more exacting jurisdictional delineation.

Overbank flooding of Chattanooga Creek and beaver activity on tributary streams have supported the development of wetland habitats. In addition there are previously excavated areas along Chattanooga Creek which have subsequently developed into wetland habitat.

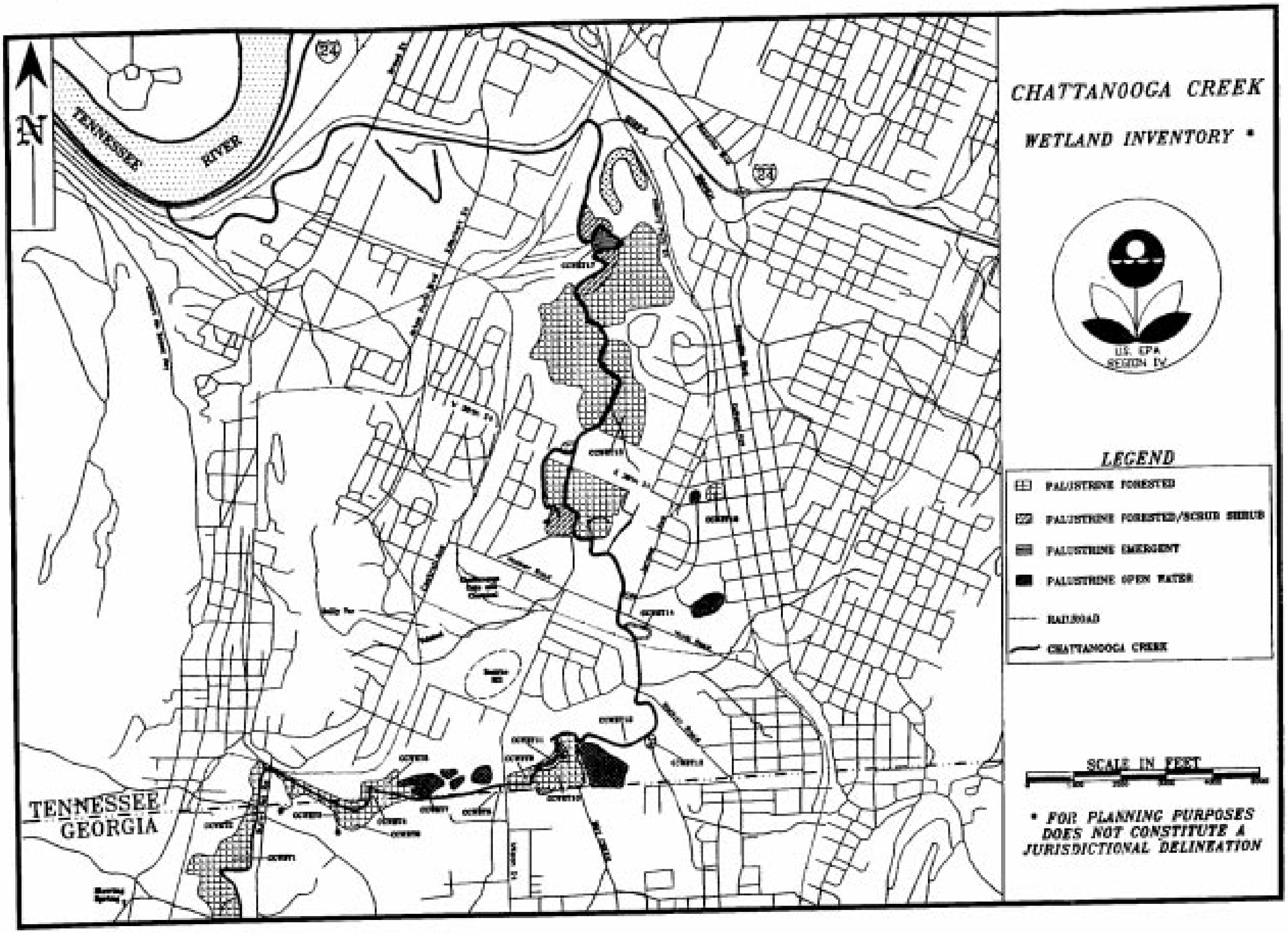
The majority of the wetlands are classified as palustrine forested wetlands. However, these forested wetlands vary greatly as to species composition, size and age of overstory trees, and stage of successional development. Early successional forested wetlands adjacent to Chattanooga Creek tend to have lower species diversity in the tree strata as compared with climax areas. Dominant overstory vegetation most prevalent in the early successional forested wetlands include silver maple, green ash, and black willow. The dominant overstory of the late successional forested wetlands includes oak species as well as a wide variety of other species. Wetland areas which were historically borrow pits have developed into a mosaic of open water habitat with wide emergent fringes interspersed around the peripheries. The areas affected by beaver activity have resulted in a mosaic of wetland habitats including emergent, scrub shrub, forested and open water areas. On the average, the indicator status of wetland vegetation along Chattanooga Creek is classified as facultative wetland which is defined as those species which usually occur in wetlands about 67 to 99% of the time, but are occasionally found in non-wetlands.

Soils within wetland areas along the creek are characterized as having hydric inclusions and exhibit low chroma matrix colors with high chroma mottle colors. These color characteristics typically develop in soils under hydric conditions.

The hydrology maintaining the bulk of wetlands appears to be influenced primarily by overbank flooding from Chattanooga Creek. Also, since much of the bedrock in this area is composed of limestone, it is likely that the wetland hydrology is supplemented by subsurface seepage.

Forested wetlands are the predominant type of wetlands in the Chattanooga Creek basin. The functions and values of these forested wetlands fall into three categories; community dynamics, physio-chemical processes, and water storage. Community dynamics include primary productivity, litterfall and decomposition, organic export for food chain support, and significant fish and wildlife habitat. Sediment deposition, retention of nutrients and toxins, and biochemical transformations constitute valuable physio-chemical processes. Bottom land hardwood wetlands function for both surface water and ground water storage. They serve for the storage of flood flows and help reduce the intensity of flood events. During wet periods these wetlands aid in the recharge of groundwater and augment low flows during dry periods. All of these functions and values are important in an urban setting due to the extensive development in the project area. The Chattanooga Creek corridor also forms an important "greenway" through the city of Chattanooga which is important for overwintering waterfowl that utilize the Tennessee River flyway. Tennessee, in general, has lost 59% of its wetlands in the period from 1780 to 1980. This is above the national average of 53%. The wetlands located in the lower Chattanooga Creek basin should be considered valuable for these reasons.

Terrestrial Habitat. Terrestrial riparian habitat in the vicinity of Chattanooga Creek consists of a stream side border of woody vegetation composed of mixed hardwood trees, shrubs, soft stemmed or herbaceous species




B-16

FIGURE B-4

and grasses. Trees in various sample areas averaged 40 to 80 feet in height. The riparian forested width varies from a narrow fringe to an approximate 200 yard wide maximum. Areas without trees are the result of fields that have become overgrown with grasses, weeds and other herbaceous species.

Threatened and Endangered Species. No Federal threatened or endangered species live in, migrate through, or are dependent upon any habitat within the project area.

Candidate Endangered Species. No Federal candidate endangered species live in, migrate through, or are dependent on any habitat within the project area.

Species of Special Concern. Great blue herons are a species of special concern that have established a rookery or nesting/roosting site in an area of large mature trees along Chattanooga Creek.

Species Diversity. A diverse array of aquatic organisms could live within the project area, however, the present extent of chemical, wastewater and urban pollution prevents the aquatic species from fully utilizing the habitat. Chattanooga Creek upstream of 38th Street presents a diverse benthic population. This aquatic diversity is evidenced by the types of macroinvertebrates inhabiting the stream, adjacent wetlands and riparian environments. Investigators observed flies, gnats, mosquitoes, midges (Diptera), May flies (Ephemeroptera), caddis flies (Trichoptera), stone flies (Plecoptera), (Hydroptilidae), dragonflies (Odonata), beetles (Coleoptera), crustaceans (Crustacea), planaria (Turbellaria), worms (Oligochaeta), leeches (Hirudinea), snails (Gastropoda) and clams (Corbicula).

This diversity decreases as one progresses downstream from 38th Street until most benthic macroinvertebrates essentially cannot live in the polluted waters in the vicinity of, and below the confluence with Dobbs Creek. Species diversity is also affected by alteration of habitat. Channelization and the formation of a soft silty substrate in Chattanooga Creek below 38th Street also limits species diversity and numbers of organisms.

Indicator Species. The Clean Water Act of 1991 emphasizes the general health of aquatic communities as a reflection of the relative condition of the aquatic environment. Benthic macroinvertebrates provide a good indication of water quality and detect environmental disturbances due to introduced pollutants. Due to their limited mobility and relatively long life span, the macroinvertebrate community is a reflection of water quality conditions over time. Aquatic pollution sensitive macroinvertebrates such as mayflies (Ephemeroptera), stoneflies (Plecoptera), and Caddis flies (Trichoptera) are good indicators of the water quality of Chattanooga Creek. Freshwater clams bioaccumulate the types of contaminants found in Chattanooga Creek and are good indicators of contaminant problems. Fish health assessments are also indicative of the health of the aquatic ecosystems.

Wildlife. Mammals which are known to be present include raccoon, squirrel, cottontails, opossum, woodchuck, beaver, muskrat and rodent species. Some white-tailed deer are also likely to be present. A few herptiles such as slider turtles and leopard frogs have been observed. No snakes were observed during the field surveys, however they are probably present. Bird life also appeared to be abundant in the area, and although no avian surveys were conducted, common species of songbirds such as bluejays, robins, cardinals, grackles, etc., as well as unprotected pest birds such as starlings and sparrows were observed.

Game Species. The project area is within an urban area and therefore hunting is prohibited. However, it is known that hunting for small game does occur. Squirrels, rabbits, raccoons, opossums, woodchucks, beaver, muskrat, turtle and frogs are species which could be hunted and eaten. Tissue samples from turtles, frogs and fish throughout the Creek indicated that PCB's were the most ubiquitous of all the organic pollutants analyzed. Although no contaminant studies have been done on the flesh of those species higher in the food chain such as the raccoons and opossums, it has been observed that the raccoons eat the small clams living in the creek and are probably bioaccumulating contaminants.

Fisheries. Fish studies conducted by the Tennessee Department of Health and Environment in 1981 and 1982 indicated that PCB's were the most ubiquitous of all the organic pollutants found in tissue samples from fish and several other aquatic animals (turtles and frogs). Several pesticides (dieldrin, DDT, Heptachlor, alpha-BHC and gamma-BHC) were also detected in some tissues.

EPA's 1992 Ecological Assessment indicates that Chattanooga Creek has a sparse population of fish. Almost all fish tissue analyzed contained pesticides and PCB's in detectable concentrations. Dieldrin, DDE and PCB-1254 were the most common contaminants. These contaminants and others were also present in fish collected from Chattanooga Creek near the Tennessee-Georgia state line. The findings in EPA's 1992 study were similar to those found in TDHE'S 1981 to 1982 study.

A Fish Health Assessment Index (FHAI) was performed on largemouth bass at only one station which was centered at Dobbs Branch. A minimum of seven fish of the same species were used to conduct the assessment. This location was the only station where this criterion was met. The FHAI indicated the largemouth bass collected were in below average health.

EPA indicated that fish sampling was difficult due to site accessibility and the sparse population of fish. All typical fish holding structures such as submerged tree tops, snags, overhangs, shoreline and bridge supports were electroshocked extensively. The lower reach of Chattanooga Creek, upstream of Nickajack Lake, was determined to be almost devoid of fish. Numbers and species increased as they progressed upstream. Fish species which have been collected from Chattanooga Creek during these studies include, but are probably not limited to, channel catfish, flathead catfish, brown bullhead, largemouth bass, rock bass, warmmouth bass, bluegill, redear sunfish, redbreast sunfish, green sunfish, hybrid sunfishes, shad, spotted sucker, white sucker, golden redhorse and carp.

<u>Benthic macroinvertebrates.</u> Aquatic invertebrates that live on solid substrates in the stream and within the creek sediments have been sampled.

A biological investigation, conducted during 1981 and 1982 by the Tennessee Department of Health and Environment, focused on the benthic macroinvertebrate community and fish tissue contaminants. EPA also studied benthic invertebrates in their 1992 assessment of Chattanooga Creek. Results from these studies indicated a relatively diverse benthic fauna was present upstream of 38th street. The stream reach from 38th Street to just above the confluence with Dobbs Branch had reduced numbers of pollution-sensitive macroinvertebrates when compared to numbers upstream. A severely degraded biological condition existed in Chattanooga Creek downstream of its confluence with Dobbs Creek. No pollution sensitive macroinvertebrates were collected below this confluence. Macroinvertebrates collected from Dobbs Branch also gave indications that it was severely degraded. Sediment samples collected upstream of Dobbs Branch (near the Southern Wood Piedmont property) and downstream were dominated by a pollution tolerant family of aquatic worms. Stream degradation was determined to be caused by habitat alteration, combined sewer overflows, and non-point source impacts from sediments and sediment-borne pollutants.

Freshwater asiatic clams (<u>Corbicula</u> sp.) are abundant throughout the Chattanooga Creek. Visible evidence indicates that these small clams are being readily consumed by raccoons and other animals. Data results show that the clam tissue bioaccumulates the contaminants found in the sediment of Chattanooga Creek. Freshwater clams were collected from three locations in Chattanooga Creek, one upstream of an area known to be contaminated with polynuclear aromatic hydrocarbons (PAHs) and two stations within the contaminated reach. The clam tissue collected upstream of Wilson Street contained no PAHs or PCBs in detectable amounts. Clams collected from the two stations downstream of 38th Street, near Alton Park School, contained PAH's and PCB's. No pesticides were detected in any of the clam tissue.

## 2. PREVIOUS REMOVAL ACTIONS

In an effort to remediate the study area, control the migration of site contaminants and provide protection for local citizens, the EPA and Tennessee Department of Environment and Conservation (TDEC) have initiated several Removal Actions. Below is a list and a short description of each action.

**a.** In the summer of 1985 EPA excavated approximately 1000 tons of waste and contaminated soil from Hamill Road Dump 3 (HRD3). This removal action was financed by Superfund. This site is about one acre in size and is bisected by the Northeast tributary to Chattanooga Creek. During sampling of an alleged wastewater discharge, TDWQC found, and subsequently sampled, the site. Laboratory results indicated high levels of PAHs. Once the contaminated soils were excavated, the area was backfilled with clean material and capped by the city's Public Works Department. Due to its proximity to the tributary, heavy precipitation events still affect the area. The area is not fenced.

**b.** In the fall of 1986 Southern Railway, under the oversight of TDEC, cleared and capped the Hamill Road Dump 1 (HRD1). HRD1, approximately three-quarters of an acre in size, is located on the banks of the creek at the intersection of Hamill and Jerome Roads. Previous sampling had detected PAHs, pesticides and elevated levels of cadmium and lead. Geonet and riprap were placed at the toe of the dump's slope, on the banks of the creek. A fence is maintained along the road, however, none exists along the creek bank.

**c.** In June 1991 TDEC requested its Emergency Response contractor to overpack some hazardous waste containers at the Landes Company Site. The site is located between the Piney Woods and Alton Park neighborhoods. Companies operating on this property over the years have specialized in metal fabrication and the manufacturing of concrete forms. It has also recently been used by an associated company to store waste. Hazardous substances which were removed included hydraulic and petroleum oils, paint wastes, adhesives, ammonium hydroxide and petroleum naphtha. Some of the overpacks remain on-site.

**d.** Sometime between 1968 and 1976 a portion of the creek near 38th Street was re-routed. During the 1992 Sediment Profile Study, a coal tar deposit was found along the old stream bed. In 1993 EPA's Emergency Response and Removal

Branch fenced this area and an area south of the Alton Park Middle School in order to minimize or prevent access.

**e.** In July of 1994, the Mead Corporation, which operated the Coke and Chemical Plant from 1968 to 1974, volunteered to demolish site structures. In addition to demolishing the coke ovens and stacks, and properly disposing of the debris, the company removed all asbestos from the structures. Mead also repaired and replaced the existing fence and gate.

**f.** From June 1997 to December 1998, the IT Corporation under contract with the U.S Army Corps of Engineers and on behalf of USEPA Region IV performed a Removal Action on portions of the Chattanooga Creek project. The Removal Action was based on the ATSDR Health Advisory, which indicated a health and safety hazard for unrestricted areas of the creek. The portions of the creek remediated by the Removal Action consisted of removal of coal tar deposits and contaminated sediments from 800 feet downstream of Hamill Road Bridge to 1350 feet downstream of E. 38th Street Bridge. In addition, remediation included the North Coal Tar Pit, South Coal Tar Pit, and Coal Tar Waste Mounds. The coal tar contaminated materials were excavated, transported to the plant area, processed and transported off-site for use as fuel at an energy generation facility and cement kilns.

## 3. SOURCE, NATURE AND EXTENT OF CONTAMINATION

### a. Nature and Source of contamination

Results of studies by the Tennessee Valley Authority (TVA) in 1980, the Tennessee Department of Health and Environment (TDHE) in 1983, and the Environmental Protection Agency (EPA) in 1990 and 1992, have shown that the Chattanooga Creek area is heavily contaminated with coal tars and coal tar products, wood tars and wood tar products, coke and coke products, and by-products and residues from several industrial operations. Many coking facilities, chemical plants, smelting and foundry works, and several dumps and landfills are located in the Chattanooga Creek area. There are also several large piles of fly ash along the banks of the creek.

The sediments in the creek and some soils along the banks are contaminated with chemicals and coal tars which generally are products of the wood preserving and coking industries. In the coking process one ton of coal produces 1200-1500 lbs of coke and 70-120 lbs of coal tar. The coal tar normally contains 50-85% pitch, and the rest consists of naphthalenes, creosotes and anthracenes. Pitch is mostly a large variety of long chain hydrocarbons along with small percentage of various PAHs. The higher the molecular weight, the more viscous the material. The pitch is used in the paving and coating industry and the other components are used in wood preserving and refined into oils, drugs and other chemicals.

The classes of compounds found in the stream are: polynuclear aromatic hydrocarbons (PAHs), chlorinated solvents, organic solvents, other chlorinated and related compounds (including pesticides and PCBs), metals, and phenols. The PAHs, other chlorinated compounds and phenols are from the semi-volatile group of compounds, while most of the organic and chlorinated solvents are volatile compounds (See Table B-4). PAHs were found in every sample collected north of Hamill Bridge to Dobbs Branch, ranging from 810 ppb to greater than 20,000,000 ppb total PAH. Pesticides and PCBs were found in twenty-six out of thirty-two samples collected. The pesticides ranged in concentration from not detected to 51,000 ppb for Alpha-BHC near Hamill Bridge. PCBs ranged from not detected to 12000 ppb in the sediment near Southern Wood products of Piedmont. Volatile organic compounds (VOC) were found in only nine of thirty-two samples and ranged from not detected to 1,760,000 ppb total VOCs near Hamill Bridge. All of these compounds are associated with the thick, black material found in the soil and sediments(See Tables B-2 & B-3).

Coal tars and pitches are generally not very soluble in water, and their movement through the environment by water may be due to mechanical action. The coal tars in the Creek are believed to have resulted from years of disposal of process liquids/sludges and surface run-off into the Creek via drainage ditches from the production facilities and from probable direct disposal events. The ash is very likely the product of fallout from the ovens and from dumping of ash into the creek and its tributaries.

Many of the compounds found are natural coal tar constituents, while others are chemicals that mix readily with the coal tar and ash. Detected chlorinated compounds probably dissolved into the tars and were retained. The 1992 EPA study found low concentrations of pesticides and PCBs that had not been found previously. While pesticides and PCBs were found intermittently along the area of concern, the higher concentrations were invariably found in areas with high concentrations of coal tar. Hamill Road #1 Dump site was suggested as a possible source, as that site had reportedly contained more than just coal tar. The tributary which enters the creek near 39th street is also thought to have transported chemicals. This small stream passes by Velsicol's Residue Hill landfill, Velsicol Chemical Company, the Chattanooga Coke and Chemical facility and Reilly Tar. Hardened pitch is likely to have encapsulated many solvents and other chemicals of concern.

The consistency of the material varies from hard asphalt-like material to a sludge. Experience with similar contaminants at creosote operations shows that the less viscous tars and sludges will migrate through sediments along opportunistic pathways, such as roots, sticks and other debris. This presents the possibility of contamination at several levels, with contamination moving from an upper layer to a lower sediment layer or radiating out along root paths.

In the 1992 EPA Sediment Profile Study, 24 different metals and low levels of cyanide were found in the sediment and surface water in the creek. 21 metals and cyanide were found in the stretch of creek from Hamill Road Bridge to Dobbs Branch, of these, 16 metals were found 22 to 32 times out of 32 samples. Beryllium, selenium, and silver were found only three times out of 32 samples, and cadmium and sodium were detected only once each (See Table B-1). Assessing frequency, concentration and the background values established in the study, it would appear that several metals are above background. Specifically, aluminum, barium, chromium, copper, lead, magnesium, mercury, potassium and zinc are significantly above background levels. While metals are no doubt present as natural constituents of the sediments, elevated levels are indicative of contamination. Iron, while not significantly above background, is still a major analyte in the sediment. Metals will adsorb/desorb from normal sediments with changes in pH and the concentration of other metals in the immediate area. Iron, aluminum and manganese in particular will form colloids with other metals and will facilitate the transport of those metals.

**b. Extent of Contamination.**

Prior to the 1997-98 Removal Action, the entire creek bed between 65 feet upstream of Hamill Road Bridge to Dobbs Branch was contaminated with coal tar either in the form of deposits or coal tar contaminated sediments. Two exceptions to this include a channelized section of the creek from 800 feet upstream of E. 38th Street Bridge to E. 38th Street Bridge and 50 feet from both sides of the City of Chattanooga sewer lines that cross the Creek. The Removal Action accomplished complete remediation of all the coal tar contamination from the areas addressed.

The remaining portions of the creek requiring remediation include the following:

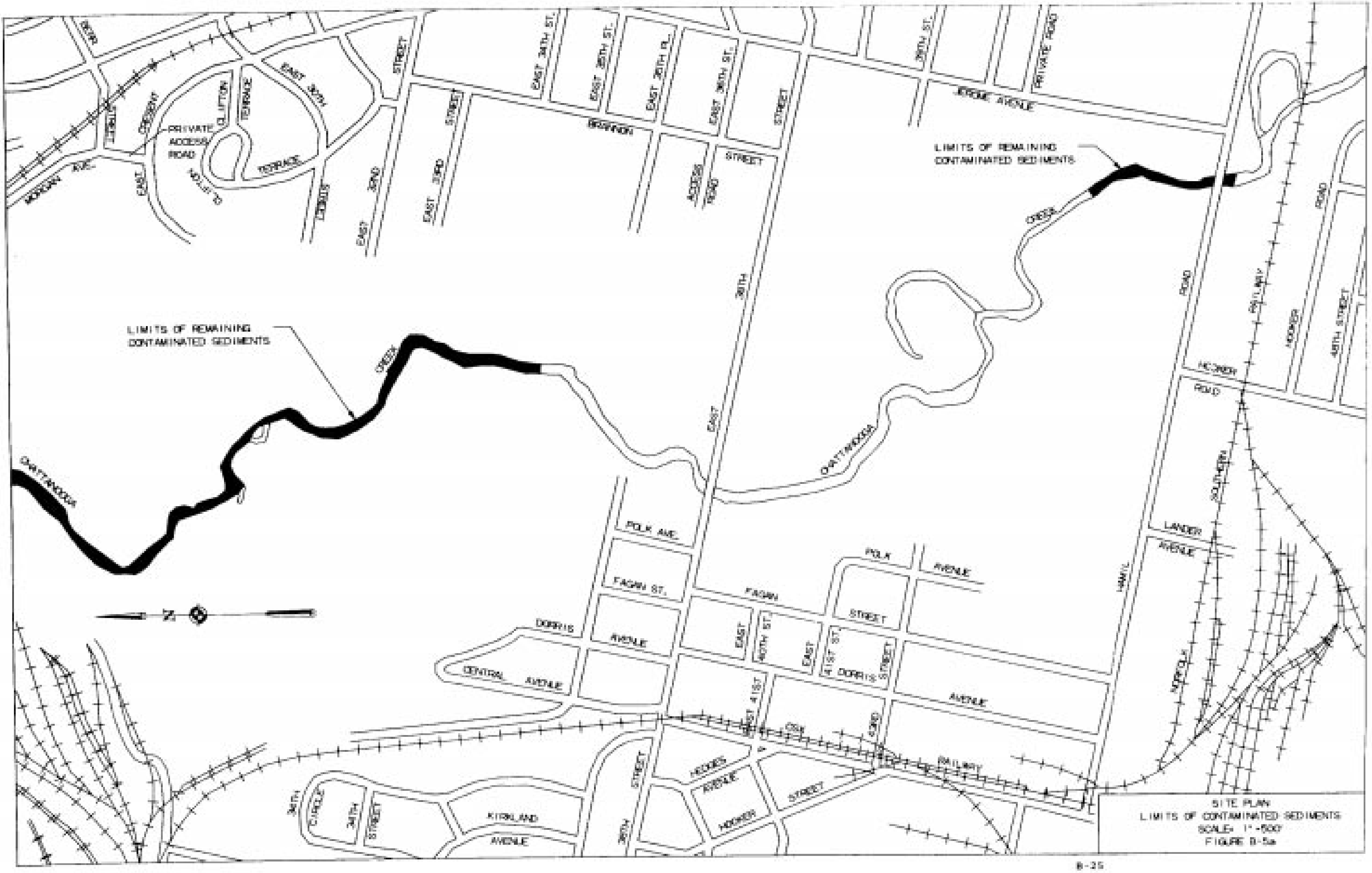
- FROM 64 ft U/S of Hamill Rd Bridge TO Hamill Rd Bridge. **(395 CY)**

- FROM Hamill Rd Bridge to 800 ft D/S of Hamill Rd Bridge (this was termed the "gray area" in the IT Removal Action Report). A quantity of 1420 CY was estimated from previous delineation and the excavation of October 1997 (assuming a 1-ft depth of coal tar below 2.5-ft of overburden and with a bedrock base) even though no coal tar was found during IT's June 1997 delineation. **(1420 CY)**

- FROM 1350 ft D/S of E. 38th St. Bridge (500 ft D/S of power line) TO Southern Wood Piedmont (this is D/S extent of additional delineation performed by IT). **(3667 CY)**

- FROM Southern Wood Piedmont TO confluence with Dobbs Branch **(8,700 CY)**. This is an extrapolation of the average volume of coal tar contaminated sediments estimated from the reach immediately upstream of this section (1.4 CY per foot length of channel).

The total estimated volume of coal tar and contaminated sediments requiring removal and disposal is approximately 14,200 cubic yards.



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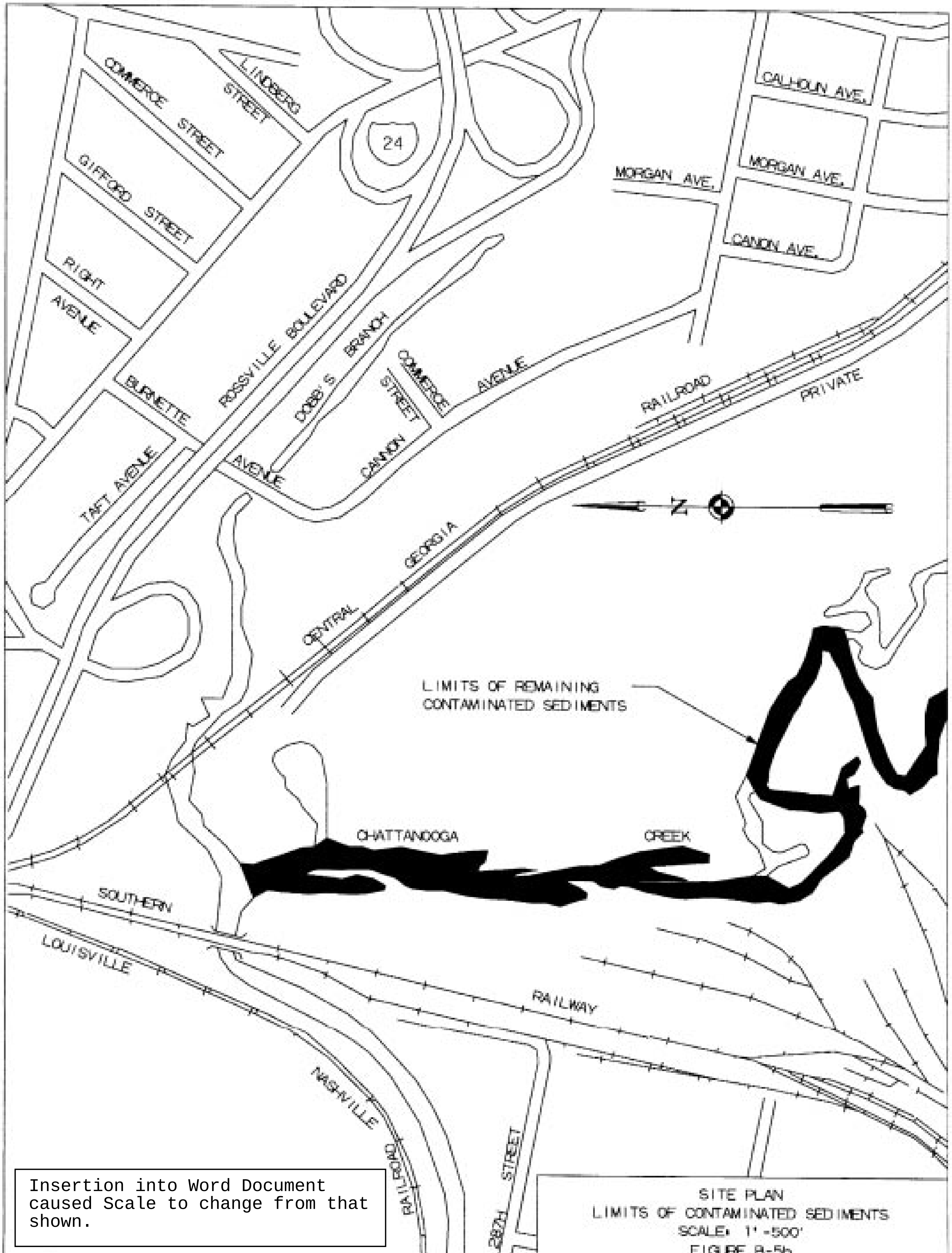


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SITE PLAN
LIMITS OF CONTAMINATED SEDIMENTS
SCALE: 1"=500'
FIGURE B-5b

## 4. ANALYTICAL

The most recent analytical data is found in the EPA documents Environmental Quality of Chattanooga Creek, May 1992, Appendix D, and Chattanooga Creek Sediment Profile Study, April/August 1992, Tables 3 through 12. In the Environmental Quality study, SW846 methods were used. The volatile and semi-volatile analyses were performed with GC/MS methods for definitive qualitative identification of compounds detected. These are comparable to the CLP methods used in the sediment profile study. One discrepancy noted in review of the data was that prior to the sediment profile study, no PCBs/Pesticides were detected.

Since the coal tar contamination in the creek bed is visually obvious, no clean up levels will be necessary to determine attainment of remedial performance standards. Visual conformation of the excavated areas will be sufficient to determine complete contaminant removal. This method was successfully used during the non-time-critical removal. If risk-based clean-up levels are developed, future analysis will be required for confirmation during excavation and for disposal of material. For confirmation, SW846 Method 4035 for PAHs would be appropriate. This is an immunoassay method which is field portable and takes about twenty minutes per sample to complete. This would be confirmed with five to ten percent of the samples being analyzed at a laboratory by Method 8310, an HPLC method for PAHs. Alternatively, a lab method for total petroleum hydrocarbons (TPH) could be used as an indicator for coal tar. This would be a fast (one day) and inexpensive procedure, and could be done at an on-Site lab. However, it would require that a value for TPH, which would compare with a PAH clean-up criteria, be determined.

**TABLE B-1**
**SUMMARY OF METALS ANALYSIS FOR CHATTANOOGA CREEK**
**HAMILL BRIDGE TO DOBBS CREEK**

| METAL | BG AVE | MAX | MIN | AVG | Detected |
|---|---|---|---|---|---|
| ALUMINUM | 3000.0 | 57000.0 | 2200.0 | 14668.8 | 32/32 |
| ARSENIC | 6.2 | 40.0 | 3.8 | 9.1 | 32/32 |
| BARIUM | 24.0 | 170.0 | 27.0 | 104.4 | 32/32 |
| BERYLLIUM | ND | 2.6 | ND | 0.2 | 3/32 |
| CADMIUM | ND | 2.4 | ND | 0.1 | 1/32 |
| CALCIUM | 803.0 | 5000.0 | 920.0 | 2625.6 | 32/32 |
| CHROMIUM | 18.3 | 280.0 | 19.0 | 99.3 | 32/32 |
| COBALT | 5.5 | 23.0 | ND | 13.6 | 31/32 |
| COPPER | 5.5 | 200.0 | 6.6 | 44.3 | 32/32 |
| IRON | 12666.0 | 46000.0 | 3100.0 | 20225.0 | 32/32 |
| LEAD | 8.0 | 230.0 | 9.7 | 78.3 | 32/32 |
| MAGNESIUM | 242.0 | 2400.0 | 210.0 | 1143.8 | 32/32 |
| MANGANESE | 330.0 | 1700.0 | 28.0 | 652.8 | 32/32 |
| MERCURY | ND | 2.0 | ND | 0.4 | 24/32 |
| NICKEL | 5.3 | 82.0 | 7.2 | 34.4 | 32/32 |
| POTASSIUM | ND | 2900.0 | ND | 1128.1 | 22/32 |
| SELENIUM | ND | 11.0 | ND | 0.6 | 3/32 |
| SILVER | ND | 11.0 | ND | 0.6 | 3/32 |
| SODIUM | ND | 270.0 | ND | 8.4 | 1/32 |
| VANADIUM | 12.7 | 54.0 | 3.9 | 25.1 | 32/32 |
| ZINC | 29.0 | 340.0 | 11.0 | 176.3 | 32/32 |

Concentrations are in mg/Kg (PPM)
All values were obtained from the 1992 EPA Stream Profile Study
BG AVE = BACKGROUND AVERAGE(Average of the three control samples)
MAX = MAXIMUM CONCENTRATION FOUND
MIN = MINIMUM CONCENTRATION FOUND
AVG = AVERAGE OF ALL SAMPLE VALUES INCLUDING NON-DETECTS(excluding background)
Detected = Number of samples above the detection limit out of the number of samples collected and analyzed
ND = NOT DETECTED ABOVE THE DETECTION LIMIT

**TABLE B-2**
**PESTICIDES/PCBs**
**HAMILL BRIDGE TO DOBBS BRANCH($\mu$g/Kg)**

| COMPOUND | MAX | MIN | AVG | #DETECTED |
|---|---|---|---|---|
| ALPHA-BHC | 51000 | 11 | 4787.1 | 11 |
| BETA-BHC | 19 | 19 | 19.0 | 1 |
| GAMMA-BHC | 240 | 240 | 240.0 | 1 |
| DELTA-BHC | 600 | 7.1 | 168.0 | 5 |
| DIELDRIN | 7100 | 100 | 3050.0 | 4 |
| 4,4'-DDT | 2900 | 40 | 1240.0 | 3 |
| ENDRIN | 250 | 98 | 174.0 | 2 |
| ENDOSULFAN II | 84 | 84 | 84.0 | 1 |
| PCB-1242 | 1200 | 190 | 742.5 | 4 |
| PCB-1248 | 12000 | 230 | 6115.0 | 2 |
| PCB-1254 | 620 | 83 | 403.3 | 7 |
| PCB-1260 | 3200 | 130 | 1034.3 | 7 |
| GAMMA-CHLORDANE | 2100 | 99 | 1099.5 | 2 |

**TABLE B-3**
**TOTAL POLYNUCLEAR AROMATIC HYDROCARBONS(µg/Kg)**
**WITH TOTAL PCB/PESTICIDES(µg/Kg)**

| LOCATION[1] | DISTANCE(FT)[2] | TOTAL PCB/PEST[3] | TOTAL PAHs[4] |
|---|---|---|---|
| 009-SD | 0 | 0/56000 | 1,200,300 |
| 010-SD | 600 | 0/79 | 40,030 |
| 011-SD | 1,125 | 0/86 | 5,786 |
| 012-SD | 1,425 | 0/138 | 18,315 |
| 013-SD | 1,800 | 0/0 | 20,717,000 |
| 014-SD | 2,400 | 0/234 | 100,840 |
| 015-SD | 2,775 | 0/NA | 66,515,000 |
| 015-SR | 2,775 | 0/9,360 | 45,472 |
| 016-SD | 3,150 | 0/0 | 23,715,000 |
| 017-SD | 4,350 | 0/999 | 208,540 |
| 018-SD | 5,550 | 190/0 | 529,800 |
| 019-SD | 7,050 | 1,820/0 | 1,781,000 |
| 020-SD | 7,650 | 1,210/0 | 602,300 |
| 021-SD | 8,850 | 15,200/0 | 754,000 |
| 022-SD | 10,050 | 1,520/0 | 3,283,000 |
| 023-SD | 11,250 | 380/0 | 968,900 |
| 024-SD | 12,150 | 520/0 | 109,300 |

1. Location Designations are from sample locations of the Chattanooga Creek Profile Study.

2. Distances in feet are approximations from sampling point 009-SD and were determined from measurements from the Figure 2 of the Chattanooga Creek Sediment Profile Study.

3. These are summations of PCBs/Pesitcides from sediments. Analytical results are from the Chattanooga Creek Profile Study.

4. These are summations of Total PAHs from sediments. Analytical results are from the Chattanooga Creek Profile Study.

NA=NOT ANALYZED

**TABLE B-4**
**COMPOUNDS AND ANALYTES ABOVE THE DETECTION LIMIT**
**FOUND FROM HAMILL ROAD BRIDGE TO DOBBS BRANCH, CHATTANOOGA CREEK**

Semivolatile Compounds

(3-and/or 4-)methylphenol
(dichlorophenyl)methoxymethylurea
1-methylnaphthalene
1,2,4-trichlorobenzene
2-chloronaphthalene
2-methylnaphthalene
3-nitroaniline
4-chloroaniline
4-nitroaniline
4-nitrophenol
acenaphthene
acenaphthylene
anthracene
benxonaphthofuran
benzo(a)anthracene
benzo(b and/or k)fluoranthene
benzo(ghi)perylene
benzo-a-pyrene
benzoacridine
benzocarbazole
benzochrysene
benzofluoranthene
benzofluorene
benzoic acid
benzoluoranthene
benzonaphthofuran
benzonaphthothiophene
benzophenanthrene
benzopyrene
benzothiophene
benzotriphenylene
binaphthalene
biphenyl
bis(2-ethylhexyl)phthalate
bis(dimethylethyl)methylphenol
bis(dimethylethyl)phenol
carbazole
chrysene
cyclobutaphenanthrene
dibenzo(a,h)anthracene
dibenzoanthracene
dibenzochrysene
dibenzofuran
dibenzopyrene
dibenzothiophene
dichloroethylbenzene
diethylbiphenyl
dihydrodimethlindene
dihydrofluorene
dihydrophenanthrene
dimethyl(phenylmethyl)benzene
dimethylanthracene
dimethylbiphenyl
dimethylethylbenzene
dimethylnaphthalene
dimethylphenanthrene
ethenylidenebis(chlorobenzene)
ethylnaphthalene
fluoranthene
fluorene
hexachlorobenzene
indeno(1,2,3-cd)pyrene
indenopyrene
methyl(phenylmethyl)benzene
methyl(propenyl)benzene
methylanthracene
methylbenaceanthrylene
methylbenzaceanthrylene
methylbenzanthracene
methylbiphenyl
methylcarbazole
methyldibenzofuran
methylfluoranthene
methylfluorene
methylphenanthrene
methylpyrene
methyltriphenylene
N-nitrosodiphenylamine/diphenylamine
naphthalene
naphthochrysene
phenalene
phenanthrene
phenylanthracene
phenylnaphthalene
phenylpentachloroethane
propenylnaphthalene
propylbenzamide
propylnaphthalene
pyrene
terphenyl
thrichloromethylbenzene
trichloro(chloromethyl)benzene
trichlorobenzene
trimethylcyclohexenemethanol
trimethylnaphthalene
[oxybis(methylene)]bisbenzene

**TABLE B-4 (CON'T)**

Pesticides/PCBs
Alpha-BHC
Beta-BHC
Gamma-BHC
Delta-BHC

Volatiles
Carbon Tetrachloride
Benzene
Toluene
Chlorobenzene

Dieldrin
Gamma-Chlordane
4,4'-DDT
Endrin
Endosulfan II
PCB-1242
PCB-1248
PCB-1254
PCB-1260

<u>Metals</u>
Aluminum
Arsenic
Barium
Beryllium
Cadmium
Calcium
Chromium
Copalt
Copper
Iron
Lead
Magnesium
Manganese
Mercury
Nickel
Potassium
Selenium
Silver
Sodium
Vanadium
Zinc

Total Xylenes
Chloromethylbenzene
Ethymethylbenzene
Dichlorobenzene
Chloromethylbenzene
Ethyl Benzene
(Methyethyl)Benzene
Undecane
Decane

## C. EVALUATION OF RISKS

The Remedial Action Scope, Goals, and Objectives are based upon reducing the risk to human health and the environment to within acceptable levels. Several studies have been performed to determine the level of risk caused by the contaminated sediments. These are briefly discussed below.

### 1. STREAMLINED RISK EVALUATION

Based on the sampling results of previous investigations, the Chattanooga Creek sediments were determined by ATSDR in 1994 to be a general public health hazard, and the coal tar deposits in the creek and floodplain were determined to represent an urgent public health and safety hazard. Local residents may expose themselves to contamination in the creek by swallowing water and sediments when swimming or bathing in the creek, and by eating fish that may be contaminated through sediment exposure. Several of the PAHs found in the coal tar waste deposits are known to be carcinogenic, and exposure to these contaminates could also cause skin irritations, especially in children. Homeless people using the creek as a water source also are at risk for several health effects, including skin, throat, and stomach irritation, and kidney and liver cancer. In addition, the coal tar deposits are a physical hazard, because children or adults could get caught or sink in the tar deposits and be injured (ATSDR 1994).

The maximum concentration of selected contaminants found in the coal tar waste deposits are listed in Table C-1, along with comparison values established to indicate possible adverse health effects. The toxicological effects of PAHs are discussed below.

PAHs are generally categorized into two groups: carcinogens and noncarcinogens. Those that have been shown to be carcinogenic to animals by the oral route are benzo(a)anthracene, benzo(a)pyrene, and dibenzo(a,h)anthracene. Benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluorathene, benzo(k)fluorathene, crysene, dibenzo(a,h)anthracene, indeno(1,2,3-cd)pyrene have been shown to be carcinogenic by the dermal route. For many of the carcinogenic PAHs, it would appear that the site of tumor induction is generally the point of first contact (i.e., stomach tumors are observed following ingestion, and skin tumors following dermal exposure).

Evidence exists to indicate that certain PAHs are carcinogenic in humans. PAHs express their carcinogenic activity through biotransformation to chemically reactive intermediates which then covalently bind to cellular macromolecules (i.e., DNA) leading to mutation and tumor initiation. The evidence of carcinogenicity in humans comes primarily from occupational studies where workers involved in such processes as coke production, roofing, oil refining, or coal gasification are exposed to mixtures containing PAHs (e.g., coal tar, roofing tar, soot, coke oven emissions, soot, and crude oil). PAHs have not been clearly identified as the causative agent, however. Cancer associated with exposure to PAH-containing mixtures in humans occurs predominantly in the lung and skin following inhalation and dermal exposure, respectively. Some ingestion of PAHs is likely due to swallowing of particles containing PAHs subsequent to mucociliary clearance of these particulates from the lung.

**TABLE C-1**

**A COMPARISON OF SELECTED PAH CONCENTRATOINS FOUND IN COAL TAR WASTE SAMPLES TO FEDERAL GUIDELINE CONCENTRATIONS TENNESSEE PRODUCTS SITE CHATTANOOGA, TENNESSEE**

| Contaminant | Maximum Creek Sediment Sample Concentration[1] (mg/kg) | Chattanooga Creek Tar Deposit Sample Concentration[1] (mg/kg) | Federal Guidelines Concentration (mg/kg) |
|---|---|---|---|
| Benzo(a)pyrene | 2100 | 1900 | 0.12[2] |
| Fluoranthene | 7500 | 8500 | 2000[3] |
| Fluorene | 2900 | 3300 | 2000[3] |
| Pyrene | 5300 | 6000 | 1500[3] |

[1]Concentrations obtained from the 1992 EPA Sediment Profile Study.
[2]Concentration obtained from Cancer Risk Evaluation Guides.
[3]Concentration obtained from the Environmental Media Evaluation Guide based on EPA RfD or RfC.

Noncancer adverse health effects associated with noncarcinogenic PAHs (acenaphthene, acenaphthylene, fluorathene, fluorene, phenanthrene, and pyrene) exposure have been observed in animals, but (with the exception of adverse hematological and dermal effects) generally not in humans. Animals studies demonstrate that PAHs tend to affect proliferating tissues such as bone marrow, lymphoid organs, gonads and intestinal epithelium. Thus, although PAHs are distributed extensively throughout the body, their major target organs appear to be the hematopoietic and lymphoid systems in animals.

The lymphoid system, because of its rapidly proliferating tissues, is susceptible to PAH-induced toxicity. The mechanism of action for this effect is most likely inhibition of DNA synthesis. No adverse effects on this system associated with PAH exposure have been reported in humans, but several accounts of lymphoid toxicity in animals were observed. Lymphoid effects in animals from PAH exposure include an increase in reticulum cells, accumulation of iron, reduced lymphoid cells, and dilated lymph sinuses.

The skin is susceptible to PAH-induced toxicity in humans. Regressive verrucae were reported following subchronic application of benzo(a)pyrene to human skin. Although reversible and apparently benign, these changes were seen to represent neoplastic proliferation. Benzo(a)pyrene application also apparently exacerbated skin lesions in patients with pre-existing skin conditions (pemphigus vulgaris and xeroderma pigmentosum). Workers exposed to substances that contain PAHs (e.g., coal tar) experienced chronic dermatitis and hyperkeratosis.

Anthracene has been associated with gastrointestinal toxicity in humans. Humans that consumed laxatives that contained anthracene (anthracene concentration not specified) for prolonged periods were found to have an increased incidence (73.4%) of melanosis of the colon and rectum as compared to those who did not consume anthracene-containing laxatives (36.5%).

The developmental effects of PAHs, especially benzo(a)pyrene, have been investigated in animals using the parental route of administration. Injections of benzo(a)pyrene to pregnant mice produced stillbirths, resorptions, and malformations, testicular changes including atrophy of seminiferous tubules with lack of spermatoids and spermatozoa in males; immunosuppression, and tumor induction (ATSDR 1990).

The mobility of PAHs in the environment is dependent in large part on their water solubility and sorption potential. The physical properties of PAHs may be broken into two categories: diaromatics, such a naphthalenes and methylnapthalenes, and all other PAHs (three or more condensed rings). Diaromatics have moderate water solubility and soil sorption potential and, thus, their movement through the subsurface tends to be less than the monoaromatics (benzene, toluene, xylenes and ethylbenzene), but substantial movement can still occur. When released into surface water bodies, these materials have moderate to high toxicity to aquatic organisms. PAHs with three or more condensed rings have very low solubility (typically less than 1 mg/l) and sorb strongly to soils. Thus, their movement in the subsurface is minimal. In addition, materials containing four to six ring PAHs are poorly biodegradable and, coupled with the potential to bioaccumulate in tissues of aquatic organisms, these materials have the potential to bioconcentrate (be found at levels in living tissue higher than present in the general surroundings) in the environment.

## 2. BASELINE RISK ASSESSMENT SUMMARY

The Chattanooga Creek Sediments are considered accessible to child and adult residents who were assumed to visit Chattanooga Creek 4 times/month for 3 months/year (summer months), or 12 visits/year. Current and future use of this area are considered the same.

Exposure routes examined in this-risk assessment are:

- inadvertent ingestion of sediment
- dermal contact with sediment

The risks associated with exposure to sediment in Chattanooga Creek are summarized in Table C-2. Since exposure to surface water is not examined, in can be assumed that the calculated risk would be higher if the water were shown to be similarly impacted, though the magnitude of the risk cannot be quantified at this time.

### a. Upper Reach Risk Summary

The sum of risks associated with currently complete exposure routes ranges from 5 x $10^{-7}$ for an adult resident to 1 x $10^{-6}$ for the lifetime resident. This estimate is within EPA's target range for Superfund sites. Non-cancer effects are not expected based on HIs less than one.

**Table C-2**
**Summary of Cancer and Noncancer Risks by Exposure Route**
**Current Use Scenario**
**Chattanooga Creek Sediments**
**Tennessee Products Site**
**Chattanooga.Tennessee**

| Location | Exposure Route | Child Resident | | Adult Resident | | Lifetime Resident | |
|---|---|---|---|---|---|---|---|
| | | Cancer | HI | Cancer | HI | Cancer | HI |
| Upper Reach(1) | Inadvertent Ingestion | 4E-07 | 0.02 | 3E-07 | 0.005 | 7E-07 | 0.01 |
| | Dermal Contact | 1E-07 | 0.004 | 3E-07 | 0.002 | 4E-07 | 0.003 |
| | **TOTAL RISK** | **5E-07** | **0.03** | **6E-07** | **0.01** | **1E-06** | **0.01** |
| Middle Reach(2) | Inadvertent Ingestion | 3E-04 | 0.3 | 3E-04 | 0.1 | 6E-04 | 0.1 |
| | Dermal Contact | 3E-04 | 0.2 | 5E-04 | 0.1 | 7E-04 | 0.1 |
| | **TOTAL RISK** | **6E-04** | **0.5** | **8E-04** | **0.2** | **1E-03** | **0.2** |
| Lower Reach(3) | Inadvertent Ingestion | 1E-06 | 0.01 | 1E-06 | 0.01 | 3E-06 | 0.02 |
| | Dermal Contact | 1E-06 | 0.01 | 2E-06 | 0.01 | 3E-06 | 0.01 |
| | **TOTAL RISK** | **3E-06** | **0.03** | **4E-06** | **0.02** | **6E-06** | **0.03** |

(1) The Upper reach is the area from Burnt Mill Bridge to the railroad bridge between Hooker and Hamill Roads.
(2) The Middle reach is the area between the railroad bridge (between Hooker and Hamill Roads) and Dobbs Branch.
(3) The Lower reach is the area between Dobbs Branch and the Tennessee River.

HI: Hazard Index (noncancer risk)
NA Not Applicable

**b. Middle Reach Risk Summary**

The sum of risks associated with currently complete exposure route ranges from 6 x $10^{-4}$ for an adult resident to 1 x $10^{-3}$ for the lifetime resident. This estimate is above EPA's target range for Superfund sites. Non-cancer effects are not expected based on HIs less than one.

**c. Lower Reach Risk Summary**

The sum of risks associated with currently complete exposure route ranges from 3 x $10^{-6}$ for an adult resident to 6 x $10^{-6}$ for the lifetime resident. This estimate is within EPA's target range for Superfund sites. Non-cancer effects are not expected based on HIs less than one.

## 3. ECOLOGICAL RISK ASSESSMENT AND SEDIMENT TOXICITY SUMMARY

**a. Results of the Ecological Risk Assessment**

The results of the ecological risk assessment show the potential for adverse effects to occur to aquatic life in Chattanooga Creek, and insectivorous small mammals and omnivorous songbirds feeding along the floodplain of the creek in the Tar Dump and Hamill Road Dump No. 3. There were also some minor risks estimated for herbivorous small mammals, muskrats, and terrestrial plants at the Tennessee Products Site.

Potential risks to aquatic life were assessed by comparing surface water and sediment concentrations with criteria and guidelines, and by conducting site-specific sediment toxicity tests. Exceedances of criteria and, guidelines occurred at all sampling locations. Number of exceedances were particularly high for sediments, and included PAHs, naphthalenes, and pesticides. Although the exceedances of criteria and guidelines indicated the potential for toxicity at all locations (including background), the sediment toxicity tests only indicated toxicity at locations DC-5U (Microtox and *Ceriodaphnia* tests) and DC-1 (*Ceriodaphnia* test only). The concentrations of PAHs and naphthalenes in sediments were particularly high for DC-5U. However, it is not certain whether this accounts for the observed toxicity. It is also not certain what accounts for the toxicity in DC-1.

For terrestrial mammals, the highest hazard index was based on potential exposure to nickel. The nickel hazard indices observed for insectivorous mammals (i.e., 410 - Tar Dump; 310 Hamill Road Dump) were higher than those observed for herbivorous mammals (i.e., 17 - Tar Dump; 14 - Hamill Road Dump). The hazard indices for insectivorous mammals were also fairly high for aluminum (59 - Tar Dump; 79 - Hamill Road Dump) and dieldrin (110 - Tar Dump). The principal contributor to the hazard index for nickel, aluminum, and dieldrin, as well as most of the other contaminants, was the potential bioconcentration and exposure through earthworm or seed ingestion. The Reference Toxicity Value (RTV) basis for all of these compounds is the protection against adverse reproductive effects. Thus, the results show the potential for adverse reproductive effects in small mammals feeding at the site, particularly for small mammals feeding on earthworms. The potential risks from exposure at the Tar Dump are higher than those at Hamill Road Dump No. 3.

There are, however, some fairly significant uncertainties associated with the estimated risks for nickel and aluminum. First, the concentrations of nickel and aluminum at the site fell within the means and ranges of background nickel concentrations measured in U.S. soils (Table 6-1). Thus, it is uncertain whether the nickel and aluminum concentrations are based on site-related activities or background concentrations. Second, there is uncertainty associated with the basis of the RTVs. In the RTV studies for nickel and aluminum, the metal was administered in drinking water as a soluble salt, which is a very bioavailable form, and thus may tend to overestimate risk based on nickel and aluminum exposure at the site. In addition, the RTV for aluminum was based on a Chronic No Effect Dose with no associated effect dose. Thus, the actual no effect dose may be higher, resulting in an overestimation of risk for aluminum.

In addition to nickel, aluminum, and dieldrin, there were a number of other chemicals that exceeded a hazard index of one for small mammals, and included beta-BHC, gamma-BHC, lead, manganese, and zinc for the insectivorous small mammals, and acetone, manganese, and zinc for the herbivorous small mammals. These hazard indices were generally much lower, and ranged from 1.5 to 16 for the insectivorous mammals, and 1.6 to 5.2 for herbivorous mammals.

The highest hazard index observed for omnivorous song birds was based on exposure to aluminum (210 - Tar Dump; 260 - Hamill Road Dump). The next highest hazard index observed was 34 for dieldrin (Tar Dump). The principal contributor to the hazard index for these chemicals, as well as for others, was the earthworm ingestion exposure route. There are some uncertainties associated with whether aluminum is at background levels, as mentioned for the insectivorous mammals. The RTV for aluminum was based on a study in which aluminum was administered in the diet in the form of a soluble salt. This may potentially overestimate the risk to aluminum, if the form of aluminum in earthworms and soils is not as bioavailable as that used in the study. The RTV for dieldrin was based on an acute LC50 for the bobwhite quail. This RTV is based on acute effects, and does not take into account the potential for chronic effects. Other chemicals which exceeded a hazard index of one included DDT, endrin, heptachlor, chromium, lead, mercury, nickel, vanadium, and zinc, with hazard indices ranging from 1.2 to 7.2. Thus, the results show the potential for adverse reproductive effects in omnivorous songbirds feeding at the site.

For the muskrat, several metals exceeded a hazard index of one, the highest of which was titanium (13). The principal contributor to the hazard index for all chemicals was the clam ingestion exposure route. The concentrations of metals in clams, for the metals which exceeded a hazard index of one, were at or below background concentrations. The results indicate that risks are at background levels, and there is a very limited potential for adverse effects to occur to muskrats, or similar organisms feeding in Chattanooga Creek.

A comparison of soil concentrations at the site with phytotoxicity data show the potential for phytotoxic effects to occur at the site. Exceedances of phytotoxicity data in Tar Dump soils occurred for gamma-BHC, dieldrin, aluminum, arsenic, chromium, lead, manganese, mercury, nickel, seienium, silver, vanadium, and zinc. Exceedances of phytotoxicity data in soils of Hamill Road Dump No. 3 included arsenic, chromium, lead, manganese, mercury, nickel, selenium, vanadium, and zinc. These chemicals occurred at concentrations on the site which have been shown primarily to cause growth reduction. However, during site investigations there were no signs of plant toxicity or stress (e.g., yellowing leaves, stunted growth, abnormal growth). Thus, although the potential for reduced growth may be possible based on the phytotoxicity evaluation, it does not appear that harmful effects are occurring to the vegetation communities at the site.

Site-specific earthworm toxicity tests were conducted to evaluate the potential for effects on soil invertebrates. The results indicated that no significant toxic effects occurred for any of the locations tested in the Tar Dump and Hamill Road Dump No. 3.

### b. Results of the Sediment Toxicity and Bioaccumulation Studies

After the April, 1996 ecological risk assessment was published, the EPA identified two areas in which the conclusions of the initial ecological risk evaluation should be refined with site-specific data: sediment toxicity and bioaccumulation. This subsection summarizes the results of these supplemental studies.

Sediment toxicity tests were conducted using samples of coal tar and sediment collected from the creek and juvenile amphipods and chironomid (midge) larvae. Sediment samples were submitted for chemical analysis.

The sediment toxicity test results showed that the sediments were toxic to both subject organisms, the amphipod, *Hyalella azteca*, and the midge, *Chironomus tentans*. Percent survival for the test organisms in the test sediments was significantly lower than percent survival in both the reference and control sediments. A growth study could not be conducted using the amphipod because of the low survival of the test organisms. Mean growth of the midge was significantly lower in the rest sediments than in the reference and control sediments.

The results of the sediment toxicity tests indicate that coal tar is toxic to benthic invertebrates. Exposure to coal tar compounds in the Chattanooga Creek was demonstrated. The weight of evidence suggests that coal tar is posing a risk to the survival and growth of benthic invertebrates in Chattanooga Creek.

An earthworm bioaccumulation study was conducted using site soil samples. No differences were observed in either survival or growth of earthworms in any of the test soils compared to either the reference or control soils. This result is consistent with the earthworm toxicity test performed in 1996.

Earthworm tissue concentrations measured at the end of the 28-day bioaccumulation study were entered into the exposure models for worm-eating mammals and birds to obtain a more realistic assessment of risks associated with that pathway. The contaminants evaluated were those which had presented a risk in the April 1996 risk assessment, as follows:

<u>Contaminants Evaluated for Worm-eating Birds:</u>

- Aluminum
- Chromium
- Lead
- Manganese
- Mercury
- Nickel
- Vanadium
- Zinc
- DDT
- Dieldrin
- Endrin
- Heptachlor

Contaminants Evaluated for Worm-Eating Mammals:

Aluminum
Lead
Manganese
Nickel
Zinc
b-BHC
g-BHC
Dieldrin

The data obtained from the analysis of worm-eating birds indicated that survival, growth, and reproduction of worm-eating birds may be at risk from aluminum, lead and vanadium. However, the hazard quotients were relatively low for these contaminants. The hazard quotient for aluminum probably overpredicts risks, and the hazard quotients for lead and vanadium did not exceed one when the lowest observable adverse effects level (LOAEL) was used as the measurement endpoint. Nevertheless, lack of risk cannot be concluded.

The data obtained from the analysis of worm-eating mammals indicate that survival, growth and reproduction of worm-eating mammals may be at risk from aluminum, lead, managanese, nickel, and dieldrin. However, the hazard quotients for manganese were relatively low, the hazard quotients for lead, nickel and dieldrin were relatively low and did not exceed one using the LOAELs, and the hazard quotient for aluminum were probably overpredictive of risk. Nevertheless, a lack of risk for these compounds cannot be concluded.

There are numerous sources of uncertainty that must be considered in interpreting the results of this type of assessment. Sources of uncertainty in this risk assessment include the following:

- Natural variability in biological and chemical systems and their combined behavior in the environment.
- The introduction of error in the process embedded in the literature that was used for obtaining life history and toxicity information.
- Data gaps, particularly incomplete contaminant data sets, missing life history, and absence of toxicity-based literature for the receptor of concern.

Conservative assumptions were made to minimize the possibility of concluding that risk is not present when a threat actually does exist. This results in error on the side of a protective outcome. When the results of the sediment toxicity analysis and bioaccumulation studies are evaluated in the context of pertinent potential uncertainties, the following conclusions can be made:

- Survival, growth and reproduction of aquatic life in the Chattanooga Creek are at risk from the coal tar deposits that are currently present in the sediments of the creek.
- Survival, growth and reproduction of worm-eating birds may be at risk from aluminum, lead and vanadium. However, lead and vanadium levels are already within an acceptable ecotoxicologically-based remedial goal range, and the risk model assumptions for aluminum suggest that there is a high degree of uncertainty that ecological risk exists from this element.
- Survival, growth and reproduction of worm-eating mammals may be at risk from aluminum, lead, manganese, nickel and dieldrin. However, lead and nickel levels are already within an acceptable ecotoxicologically-based remedial goal range. Further, the risk assumptions for aluminum and manganese suggest that there is a high degree of uncertainty that ecological risk exists from these elements.

# D. IDENTIFICATION AND SCREENING OF REMEDIATION OPTIONS

This chapter identifies the remedial technologies that may be appropriate for meeting the remediation objectives for the Chattanooga Creek site. This includes identifying options involving in-situ remediation, removal of the contaminated media from the creek, ex-situ remediation and containment. After identification of various options they were screened based upon effectiveness and implementability.

## 1. REMEDIAL ACTION OBJECTIVES

The Remedial Action Objectives are as follows:

- Reduce the human health risks to within acceptable limits by preventing dermal contact and ingestion of the coal tar contaminated sediments. (See Section C for summary of Human Health Risk Assessment).

- Reduce ecological risks to within acceptable limits by preventing exposure to the contaminated sediments (See Section C for summary of Ecological Risk Assessment).

## 2. TECHNOLOGY SCREENING

Preliminary screening was performed to narrow the list of technologies that are potentially applicable for remediation of Chattanooga Creek. The preliminary screening took into to consideration the site contaminants and their current deposition in evaluating technologies in terms of effectiveness and implementability. The technologies included both in-situ and ex-situ options as well as treatment and containment options. Those that had potential were retained for further consideration.

The number of technologies retained from the preliminary screening were still too numerous to carry on for detailed evaluation, therefore another phase of screening was performed. In this second phase the technologies were evaluated in slightly more detail to identify problems that may eliminate them from further consideration. Given below is a brief description of each of the technologies retained as well as items that were considered in evaluating them for their potential effectiveness and implementability at this site. The discussion is broken down into in-situ, ex-situ and removal options. The only in-situ option retained was a containment option. Ex-situ technologies retained include both containment and treatment options. Removal options are an element of all ex-situ options.

Table D-1 compares various in-situ options that were evaluated. These options would not involve excavation of any contaminated media. Due to the characteristics of the site and contaminants the only in-situ technology held for further analysis was re-routing and containment. There are no in-situ treatment technologies that have been proven effective for coal tar derived PAH-contaminated sediments that could be implemented in the Chattanooga Creek stream bed.

Table D-2 shows the ex-situ treatment technologies which were considered for remediating the contaminated sediments. The contaminated material in all of these cases would be either dredged or excavated. Furthermore, the final disposition of the treated sediments must be addressed. For options such as landfilling this is not a consideration; however, all on-site treatment options must determine the most suitable final destination of the treated material (e.g. sanitary landfill or other).

**TABLE D-1: PRELIMINARY SCREENING OF IN-SITU TREATMENT TECHNOLOGIES**

| OPTION | | EFFECTIVENESS | IMPLEMENTATION | COST | RETAINED |
|---|---|---|---|---|---|
| **BIOLOGICAL** | INTRINSIC BIODEGRADATION | NO | NO | L | NO |
| | BIOVENTING | NO | NO | L | NO |
| **PHYSICAL** | STABILIZATION | NO | NO | M | NO |
| | SOIL VAPOR EXTRACTION | NO | NO | M | NO |
| | SOIL FLUSHING | NO | NO | M | NO |
| | NATURAL ATTENUATION | NO | NO | L | NO |
| | RE-ROUTING AND CONTAINMENT | YES (?) | YES (?) | L-M | YES (?) |
| **THERMAL** | VITRIFICATION | YES(?) | NO | H | NO |

(?) - indicates uncertainty in effectiveness or implementation
H - indicates high cost
M - indicates medium cost
L - indicates low cost

**TABLE D-2: PRELIMINARY SCREENING OF EX-SITU TREATMENT TECHNOLOGIES**

| TREATMENT TECHNOLOGIES | | EFFECTIVENESS | IMPLEMENTATION | COST | RETAINED |
|---|---|---|---|---|---|
| **CONTAINMENT OPTIONS** | | | | | |
| **PHYSICAL** | ON-SITE LANDFILL | YES | YES | M | YES |
| | OFF-SITE LANDFILL | YES | YES | M-H | YES |
| **TREATMENT OPTIONS** | | | | | |
| **BIOLOGICAL** | BIOSLURRY | YES (?) | YES | M-H | YES |
| | LAND FARMING | NO (?) | NO | M | NO |
| | FUNGAL TREATMENT | NO (?) | NO | M-H | NO |
| | COMPOSTING | YES (?) | YES | M-H | YES |
| **PHYSICAL** | SOIL WASHING | NO (?) | YES (?) | H | NO[1] |
| | STABILIZATION | YES (?) | YES | H | YES (?) |
| | RECYCLING (Coal | YES (?) | YES (?) | M-H | YES (?) |
| | WASTE-TO-FUEL | YES | YES | M-H | YES |
| **CHEMICAL** | SOLVENT EXTRACTION | YES (?) | YES | H | YES[1] |
| | CHEMICAL REDUCTION | YES | YES | H | YES |
| | CHEMICAL OXIDATION | NO | YES (?) | H | NO[1] |
| | PYROLYSIS | YES | NO (?) | H | NO |
| **THERMAL** | ON-SITE | YES | YES | H | YES |
| | OFF-SITE TREATMENT | YES | YES | H | YES |
| | THERMAL DESORPTION | YES | YES | H | YES |
| | VITRIFICATION | YES | NO | H | NO |

1 - These options may be useful as part of a treatment process but not stand alone processes
(?) - indicates uncertainty in effectiveness or implementation
H - indicates high cost
M - indicates medium cost
L - indicates low cost

## 3. IN-SITU OPTION

Re-routing and Containment

This option consists re-routing the creek and taking the material from the newly excavated channel and backfilling into the existing channel. This will reduce exposure of the surrounding environment to the coal tar deposits and coal tar contaminated sediments. Items to consider when evaluating this option are as follows:

- Re-routing will require avoiding known or suspected contaminated areas along the existing creek. In addition, samples would have to be taken for the entire length of the proposed alignment to ensure it is not going through an undiscovered contaminated area.

- If the realigned channel is too close to the existing channel, contaminants from existing deposits may leach into the new channel. This also indicates that re-routing may not isolate contamination from the groundwater.

- May require extensive relocation of utilities.

- The banks of the new channel would require protective measures to prevent meandering back into contaminated areas.

- Extensive real-estate acquisition may be required.

- Protection of wetlands may require significant and costly precautions and, possibly, permits from State and Federal regulatory entities, despite the NCP's and CERCLA's statements that permits are not required.

- If both the remediated channel and the diversion channel are left open at the conclusion of the remediation construction, then the creek might be less likely to overflow onto the surrounding floodplain in the future.

Although this option has many potential problems that are not present in the other options, it also does not contain some of the problems associated with the other options such as removal and treatment of the contaminated material. Therefore, this option will be retained for detailed evaluation of the FFS.

### 4. REMOVAL OPTIONS

In addition to treatment options there are several options that will be evaluated for the removal of the coal tar deposits and sediments from Chattanooga Creek. These options are listed below along with some discussion of items to be considered in evaluating whether or not further consideration is warranted. Items that are common to all of the removal options are listed below.

- Haul Road Network - all removal options will require a haul road network to obtain access to the creek for contaminant removal. In addition, contaminated deposits will require transport to a centralized area for treatment or staging or to an off-site disposal area. This network will require extensive removal of trees and other vegetation as well as temporary disturbance of wetlands.

- Moisture Content - since the contaminants are currently in an aquatic environment, the moisture content of the contaminated media will be high. The degree of moisture will depend upon the removal option selected, but some degree of dewatering is likely and should be considered when selecting a treatment option.

- Currently it is not known if simple visual appearance will be adequate to remove contamination to the action levels. Therefore, confirmatory sampling of the creek bottom may be required to verify attainment of action levels.

**a. Hydraulic Dredging**

Use of a small hydraulic dredge with a horizontal auger was considered as a potential option for sediment removal. A hydraulic dredge includes a cutterhead and pumps to remove sediment via a slurry. The slurry is pumped at relatively high rates (1500 gpm $\pm$) with a solids content ranging from 10 to 30 percent. Items to consider when evaluating this option are as follows:

- Conventional sediment removal technique.

- Low to Moderate turbidity and suspension of contaminants in the water column that may be transported downstream.

- High degree of vertical and horizontal accuracy.

- Generation of Water - sediments are removed in a slurry containing 10% to 30% solids. With an estimated volume of approximately 14,200 $yd^3$ the volume of slurry at 10% and 30% solids would range from 29,000,000 to 10,000,000 gallons respectively to be treated.

- Transportation of Wastes - since the slurry is approximately 10% to 30% solids the volume of waste to be collected and transported to a centralized treatment/staging area could be up to 10 times that of conventional excavation methods. Potential methods of transportation include tanker truck or piping with a series of pumps and lift stations.

- Visual Confirmation - hydraulic dredging will not allow direct visual confirmation of the removal of all coal tar stained sediments although the slurry discharged from the dredge may provide a color distinction between coal tar contaminated sediments and natural sediments.

- Confirmatory Sampling - if required, will require special equipment to obtain a sample of the remaining sediments through the water.

- Hydraulic dredging requires a minimum water depth of approximately 2 feet to effectively remove sediments.

**b. Mechanical Dredging**

This option would consist of mechanically dredging the deposits and sediments with a backhoe or clamshell through the water with the equipment working from the shoreline. This method is being used at a major Superfund site in Louisiana for similar type contamination of sediments. There are differences in that the site in Louisiana is a relatively wide deep slow moving Bayou whereas this site is a narrow shallow relatively fast moving creek. Items to consider when evaluating this option are as follows:

- Conventional excavation equipment can be used.

- Deposits and sediments will have a high moisture content after removal and possibly require dewatering.

- Turbidity - removal of the deposits and sediments will cause significant turbidity in the water column which may transport contamination downstream. Some control measures such as silt curtains and floating absorbents can be utilized to reduce this problem, but some contaminants will likely make it to downstream areas.

- Transportation - approximately 14,200 $yd^3$ of material to be transported to a centralized treatment/pretreatment area.

- Visual Confirmation - mechanical dredging will not allow direct visual confirmation that all coal tar stained sediments have been removed. Confirmation of removal will be possible to a certain degree by inspection of the material as it is excavated.

- Confirmatory Sampling - if necessary, will require special equipment to obtain a sample of the remaining sediments through the water.

### c. Dewatering and Excavation

This option consists of segmenting the creek with an upstream and downstream cofferdam, diverting the creek flow around the segment, dewatering the segment within the cofferdams, and excavation of the deposits and sediments in the dry. Once the contaminated deposits and sediments have been removed, the upstream cofferdam would be removed and another cofferdam placed downstream of the previous segment. Items to consider when evaluating this option are as follows:

- Use of conventional excavation equipment.

- Deposits and sediments will have a moderate to high moisture content after excavation.

- Turbidity - no turbidity problems under normal flow conditions. Flooding situation may flood segment and cause some discharge of disturbed contaminated material downstream.

- There is a potential for an increase in the flood levels in backwater due to barrier obstruction in stream. The typical requirement is that changes in the flood plain do not increase the 100-yr flood elevation by more than 0.2 feet either upstream or downstream of the change. Since Chattanooga Creek has large sewer pipes currently crossing the creek, additional barriers at a lower top elevation may not pose a significant problem.

- Transportation - approximately 14,200 $yd^3$ of material to be transported to a centralized treatment/pretreatment area.

- Visual Confirmation - dewatering and excavation in the dry will allow direct visual confirmation of the removal of coal tar deposits and coal tar stained sediments.

- Confirmatory Sampling - if required, samples can be obtained relatively easily since the channel bottom will not be submerged.

Based upon considerations given for the three removal options, the "Dewatering and Excavation" offers the best overall removal performance with the least potential problems. This option was successfully used during the 1997-1998 Early Removal Action implemented at the creek. Therefore, all ex-situ treatment/disposal options will have the "Dewatering and Excavation" removal option as a component.

## 5. CONTAINMENT OPTIONS

The following options would all be preceded by a removal option as previously discussed. These options are described and considerations for retaining them or rejecting them are presented for each option that was not screened out in Table D-2. These options do not treat the material; therefore, there is no reduction in volume or toxicity of the contaminated material. The contaminants are prevented from migrating due to their containment.

**a. On-Site Landfill**

This option involves containment not treatment. The contaminated material would be excavated or dredged, a suitable landfill location would be selected and constructed, and the contaminated material would be placed into the landfill and capped. A monitoring system would be in place to insure that the integrity of the landfill was maintained. A leachate collection system must also be constructed and operated.

- Landfills offer relatively short-term effectiveness as compared to some treatment options.

- The contaminated sediments may require solidification to increase their strength and reduce potential settlement prior to landfilling. Solidification is also effective at reducing the leachability of metals but is not effective at reducing the leachability of volatile organics. Organics in the contaminated sediments may hinder hydration of the solidified material.

- Long-term controls (monitoring) would be required.

- This option would be less costly than many others and should be easily implemented. However, some of the contaminants are volatile and some type of treatment and or consideration for the volatiles must be addressed prior to landfilling.

- Finding a suitable landfill location may be difficult.

The on-site landfilling option shall be retained for detailed evaluation.

**b. Off-Site Landfill**

The contaminated material would be dredged or excavated and hauled off-site to a permitted treatment and disposal facility. This option could involve some pre-treatment operations such as stabilization prior to landfilling.

- Off-site landfilling is easy to implement but costly. It is usually only economical for smaller sites.

- No treatment is achieved; therefore, this is a containment option with short-term effectiveness, but it is not generally considered to be a permanent, long-term solution.

Because this technology is similarly priced to some Off-Site treatment options it will not be retained for further evaluation.

## 6. TREATMENT OPTIONS

The following options would all be preceded by a removal option as previously discussed. These options are described and considerations for retaining them or rejecting them are presented for each option that was not screened out in Table D-2.

**a. Bioslurry (Reactor Based Biotreatment)**

A bioslurry reactor would involve mixing the contaminated sediments with water and providing conditions suitable for microbial growth. Oxygen, pH, temperature, retention time and mixing are all important parameters which must be considered. By providing the necessary conditions and nutrients, microbial growth is stimulated and the contaminants are degraded biologically into less toxic or non-toxic compounds. A bioslurry process may involve the following elements: excavation, mixing the slurry, bioreactors and dewatering. A tank based bioreactor allows greater control over the process, superior mixing, and greater control over any potential emissions. Emissions are a concern due to the volatile compounds found in some of the sediment samples. These are considerations when evaluating this technology:

- There would be long-term effectiveness and permanence through treatment which would also result in a reduction of toxicity, mobility and volume.

- Biotreatment has the potential for being lower in cost as compared to other treatment options.

- A treatability study would be required to show that biotreatment is effective for this site.

- Biotreatment could take longer to implement than most of the other technologies due to required studies and potentially long treatment times.

- Some of the higher molecular weight PAH's detected at the site may not be amenable to biotreatment. Furthermore, many of those not amenable to treatment may be carcinogenic.

- Depending upon the degree of treatment achieved with biotreatment, long-term controls (e.g. landfilling) may be required for the final treated material.

Because of the lack of data supporting successful remediation of larger molecular weight PAH's and the uncertainty about meeting the ARARs, this technology is not retained for further detailed analysis.

**b. Composting**

Composting is a bioremediation/stabilization technology that can be applied to contaminated soils and sediments. Contaminated materials are combined with organic matter, creating an environment in which microorganisms can degrade the contaminants. All materials and equipment used for composting are commercially available.

These are considerations when evaluation the technology:

- Although a portion of the contaminants may be destroyed a portion may be bound tightly to the organic compost material. The long term stability of this binding is uncertain. Some contaminants can become strongly bound to the compost matrix and not be detected using standard extraction procedures.

- Composting results in an overall volumetric increase in material because of addition of amendment material.

- Substantial space is required for composting operations.

- Composting has the potential for being lower in cost than some treatment options.

- A treatability study would be required to show that composting is effective for site specific materials.

- Composting could take longer to implement than most of the other technologies due to the required studies and potential long treatment times.

- Odors produced during composting may be offensive to nearby residents.

- Some of the higher molecular weight PAH's detected at the site may not be amenable to composting. Further, many of those not amenable to treatment may be carcinogenic. Some contaminants may only be partially decomposed. In some cases the decomposition products may be more toxic than the original contaminant

- Depending upon the degree of treatment achieved with composting, long-term controls (e.g. landfilling) may be required for the final treated material.

- Heavy metals are not treated by this method and can be toxic to the microorganisms required in the composting process.

Because of the lack of data supporting the successful remediation of the larger molecular weight PAH's and the uncertainty about meeting the ARARs, this technology is not retained for further analysis.

### c. Solidification

This technology incorporates the contaminated sediments into a solid matrix by mixing the sediment with a binder such as cement, flyash or kiln dust. The goal is to immobilize the contaminants within the solid matrix and/or to increase the strength of weak materials prior to landfilling.

- Solidification is not a destruction technology and organic compounds are difficult to immobilize. The treated material may require long-term controls; therefore, this is not as permanent as some of the other technologies presented here.

- Solidification is in general not suitable for treating volatiles or easily leachable compounds. It may not be possible to find a suitable solidification mix which would result in immobilized contaminants.

- Because some of the contaminants are volatile, emissions control equipment may have to be used which would increase costs and add to the complexity of the process.

- Solidification has been used extensively to treat metals-contaminated soils, but little information is available concerning its effectiveness for organics.

This technology is not retained for detailed evaluation as a stand-alone option; however, it may be useful as part of another option.

### d. Solvent Extraction

Solvent extraction is an ex situ separation and concentration technology in which a nonaqueous liquid solvent is used to remove organic and/or inorganic contaminants from wastes, soils, sediments, sludges or water. The technology produces a treated fraction and a concentrated contaminated fraction that requires further treatment to recover, destroy, or immobilize the contaminants. It concentrates contaminant thereby reducing the volume of material requiring further treatment.

Commonly used solvents include liquid carbon dioxide, propane, butane, light oil, triethylamine, acetone, methanol, hexane, dimethyl ether, crude oil, benzene, isopropyl ether, toluene, tricresyl phosphate, methyl isobutyl ketone, methyl chloride, and butyl acetate.

Most solvent extraction technologies are not effective for the removal of inorganic contaminants such as heavy metals. They may also have difficulty removing hydrophilic and high molecular weight organic compounds. High concentrations of organic compounds in the feed can reduce extraction efficiency and processing rates

This process is one of the most costly presented.

Because of the high cost of implementation and the lack of destruction of the contaminant this technology will not be retained for further detailed evaluation.

### e. Chemical Reduction

Chemical reduction is an innovative technology that has been tested at a pilot-scale on coal tar contaminated sediments from Hamilton Harbor, Ontario. The process used is patented by Eco Logic, Inc. and is a thermal reduction (no oxygen) process that has also been tested for PCB-contaminated sediments from Bay City, Michigan as part of the EPA's SITE (Superfund Innovative Technology Evaluation) program. The breakdown products of this process are methane (reduced carbon) and hydrogen gas.

- This process has not been used to remediate a site and has only been studied on a pilot-scale at two sites. Consequently, there is a lack of technical performance and cost data.

- It should be effective for destroying PAH and coal tar contaminants which would result in a permanent and long-term solution.

- This process, due to its complexity and lack of experience is one of the most costly presented here.

Because of the high cost and lack of available data supporting this technology it will not be retained for further detailed evaluation.

**f. On-Site Incineration**

Incineration is a process that thermally oxidizes the contaminants in a controlled system. The primary units of an on-site incineration system would include (1) a contaminated media feed system, (2) a main combustion chamber (e.g. rotary kiln), (3) a secondary combustion chamber, and (4) air emission control devices.

- Incineration is very effective for treating coal tar and PAH compounds. This would result in a permanent remedy.

- Incineration has been used successfully at full-scale at other sites. Implementing it at this site poses no known technical problems that can not be overcome; however, this material does pose potential material handling problems.

- The treated material would be non-hazardous for PAHs but may require solidification if hazardous levels of metals remain after thermal treatment.

- Incineration is a relatively costly process. The expected high moisture content of the sediments will increase these costs.

On-site incineration using a mobile or transportable system is a proven technology for contaminated media of this type. Therefore, it is retained for further evaluation.

### g. Off-Site Treatment

There are off-site facilities which are licensed to treat hazardous materials. For organic contaminants such as PAHS the process used is most commonly incineration. The process utilized is similar to that described under on-site incineration; however, the particular process and how it is operated may be different. Potential also exists for the use of innovative technologies for off-site treatment. Promising off-site innovative technologies include recycling the coal tar deposits and waste-to-fuel for both the coal tar deposits and contaminated sediments. Consideration for off-site treatment options include:

- Off-site incineration is usually more expensive than on-site incineration particularly since the estimated quantity of material is 14,200 cubic yards. Furthermore, transportation costs may be very high depending upon the location of the treatment facility.

- Most of the considerations presented for on-site incineration are applicable for off-site incineration: permanence, effectiveness, and implementability.

- Recycling the coal tar deposits may be a possible option; however, there probably is little or no potential for recycling the contaminated sediments. For the purposes of this document, recycling refers to options where the coal tar is processed and used in a product (e.g. asphalt pavement).

- Waste-to-Fuel may be applicable to both the coal tar deposits and coal tar contaminated sediments. It consists of blending the contaminated material with coal and using the mixture as fuel in coal-fired boilers. The ratio of coal to contaminated material is dependent upon the BTU content of the coal tar deposits and creek sediments as well as moisture content and other factors. Treatability studies would need to be performed to determine the feasibility of using these materials.

Off-site treatment is retained for further detailed evaluation.

### h. Thermal Desorption

Thermal desorption is effective in removing volatile and semi-volatile compounds from contaminated soils, sediments and sludges. The main elements of the process would include (1) a feed system, (2) a main volatilization chamber, (3) a secondary thermal oxidizer or other treatment (for the vapor stream) and (4) an exhaust gas emissions control system.  The following considerations pertain to thermal desorption systems:

- It would result in long-term effectiveness and permanence through treatment of the sediments and destruction of contaminants.

- A treatability study is recommended in order to determine whether this technology would be effective for the coal tar deposits.  PAH's may be removed, but extremely flammable compounds could ignite in the desorption chamber, and the tar compounds could foul the volatilization chamber. These issues must be addressed and engineered prior to selecting this technology.

- Thermal desorption has the potential of reducing PAH contaminant levels to the extent necessary for protection of human health and the environment, despite the presence of metals, PCB's and pesticides.

- Media with high moisture contents increase the costs of operation for this process.

- Thermal desorption costs for this site are estimated to be in the same range as incineration.

Thermal desorption is retained for further detailed evaluation.

**i.  Summary/Future Screening**

In the next phase of technology evaluation, process options within a specific technology are selected for detailed evaluation.  In general, the options will be evaluated for Effectiveness, Implementability, and Cost.  A more detailed description of the evaluation criteria is presented in Section E.

Table D-3 shows all of the remediation options which have been retained for further detailed evaluation.  The removal options are not listed; however they are required for the ex-situ options.

**TABLE D-3: REMEDIATION OPTIONS RETAINED FOR DETAILED EVALUATION***

| TECHNOLOGY | DEMONSTRATED RELIABILITY | GENERAL DATA NEEDS |
|---|---|---|
| RE-ROUTING AND ENCAPSULATION | Encapsulation - full-scale for a variety of soils and sediments (Solidification/stabilization) | Encapsulation - Bench-scale tests to determine proper applications, effectiveness and costs |
| ON-SITE LANDFILL | Implemented at many sites for many contaminants, a containment option - long-term controls required, potential for solidification prior to landfilling | Further information on costs, geotechnical characteristics of the site |
| ON-SITE THERMAL DESORPTION | Pilot-scale demonstrations for coal tar (PAH's), full-scale for other contaminants | Bench-scale tests to determine proper applications, effectiveness and costs |
| ON-SITE INCINERATION | Full-scale for PAH's in soils and sediments | Bench-scale tests to determine proper applications, effectiveness and costs |
| OFF-SITE WASTE-TO-FUEL | Full-scale for PAH's in soils and sediments | Bench-scale tests and waste analysis to determine , applicability and costs |

## E. DETAILED ANALYSIS OF REMEDIATION ALTERNATIVES

### 1. GENERAL

This chapter presents a detailed analysis of the screened remediation alternatives. The requirements of each alternative were analyzed with respect to requirements stipulated in "The National Oil and Hazardous Substance Pollution Contingency Plan" 40 CFR 300 (March 1990) and the "Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA" (April 1989). The following introduction describes the evaluation criteria. Subsequent sections analyze the remediation alternatives with respect to the evaluation criteria.

Cost estimates to implement each of the options were developed. The accuracy of these estimates is within the plus 50% to minus 30% range recommended by the FS guidance. This accuracy relies on the thoroughness of previous investigations and estimates of contaminated material in the creek requiring removal and/or treatment. If further investigations result in a change of estimated quantities, the cost estimates provided should be revised accordingly. MCACES GOLD EDITION software was used to perform the cost estimates. Information not readily available from the MCACES databases was derived from other sources including vendors, RACER, and the MEANS. The following factors were applied to each of the estimates:

- The Overhead was either itemized or a rate of 25% to 40% was applied to direct costs and consists of field overhead; home office overhead; supervision, engineering and office personnel; contractor quality control; pollution insurance; builders risk and public liability insurance; bond; Health and safety.

- Profit of 8%

- The price level date for the cost estimates of the feasibility report is 1 October 1999.

- A design and construction contingencies are included in the estimated quantities.

- In accordance with the Interagency agreement, a budgetary cost factor of 23% is applied to the construction cost which consists of 1% Engineering and Design, 6% Supervision and Administration, 1% Quality Assurance, and 15% bid contingency.

## 2. DESCRIPTION OF EVALUATION PROCESS

### a. Introduction

The detailed analysis of options consists of the analysis and presentation of the relevant information needed to allow decision-makers to select a site remedy. During the detailed analysis, each option was assessed against the evaluation criteria described here. The results of this assessment were used to compare the options and identify the key parameters. This approach to analyzing options is designed to provide decision-makers with sufficient information to adequately compare the options, select an appropriate remedy for a site, and demonstrate satisfaction of the CERCLA remedy selection requirements in the record of decision (ROD). The detailed analysis of options consists of the following components:

- Further definition of each option, with respect to the volumes or areas of contaminated media to be addressed, the technologies to be used, and any performance requirements associated with those technologies.

- An assessment and a summary profile of each option against the evaluation criteria.

- A comparative analysis among the options to assess the relative performance of each option with respect to each evaluation criterion.

The specific statutory requirements for remedial actions that must be addressed in the ROD and supported by the FFS report are:

- They are protective of human health and the environment,

- They attain ARARs (or provide grounds for invoking a waiver),

- They are cost-effective,

- They utilize permanent solutions and alternative treatment technologies or resource recovery technologies to the maximum extent practicable, and

- They satisfy the preference for treatment that reduces toxicity, mobility, or volume as a principal element or provide an explanation in the ROD as to why the alternative does not.

In addition, CERCLA places an emphasis on evaluating long-term effectiveness and related considerations for each of the alternative remedial actions (Section 121(b)(1)(A)). These statutory considerations include:

- The long-term uncertainties associated with land disposal;
- The goals, objectives, and requirements of the Solid Waste Disposal Act (SWDA);
- The persistence, toxicity, and mobility of hazardous substances and their constituents, and their propensity to bioaccumulate;
- Short- and long-term potential for adverse health effects from human exposure;
- Long-term maintenance costs;
- The potential threat to human health and the environment associated with excavation, transportation, and redisposal, or containment.

**b. Overview of Evaluation Criteria**

Nine evaluation criteria have been developed to address the CERCLA requirements and considerations listed above, and to address the additional technical and policy considerations that have proven to be important for selecting among remedial alternatives. These evaluation criteria serve as the basis for conducting the detailed analyses during the FFS and for subsequently selecting an appropriate remedial action. The evaluation criteria are shown in Table E-1.

The detailed analysis provides the means by which facts are assembled and evaluated to develop the rationale for a remedy selection. Therefore, it is necessary to understand the requirements of the remedy selection process to ensure that the FFS analysis provides the sufficient quantity and quality of information to simplify the transition between the FFS report and the actual selection of a remedy. The analytical process described here has been developed on the basis of statutory requirements of CERCLA Section 121. The nine evaluation criteria encompass statutory requirements and technical, cost, and institutional considerations the program has determined appropriate for a thorough evaluation.

**TABLE E-1: CRITERIA USED IN ANALYSIS OF REMEDIAL ALTERNATIVES**

| SCREENING CRITERIA | EVALUATION CRITERIA | ROLE OF CRITERIA DURING REMEDY SELECTION |
|---|---|---|
| Effectiveness | Overall protection of human health and the environment | "Threshold" Factors |
| | Compliance with ARARs | |
| | Long-term effectiveness and permanence | "Primary Balancing" Factors |
| | Reductions in toxicity, mobility and volume through treatment | |
| | Short-term effectiveness | |
| Implementability | Implementability | |
| Cost | Cost | |
| | State acceptance | "Modifying" Considerations |
| | Community acceptance | |

Assessments against two of the criteria relate directly to statutory findings that must ultimately be made in the ROD. Therefore, these are categorized as threshold criteria in that each alternative must meet them. These two criteria are:

- Overall protection of human health and the environment - The assessment against this criterion describes how the alternative, as a whole, achieves and maintains protection of human health and the environment.

- Compliance with ARARs - The assessment against this criterion describes how the alternative complies with ARARs, or if a waiver is required and how it is justified. The assessment also addresses other information from advisories, criteria, and guidance that the lead and support agencies have agreed is "to be considered."

The five criteria listed below are grouped because the represent the primary criteria upon which the analysis is based.

- Long-term effectiveness and permanence - The assessment of alternatives against this criterion evaluates the long-term effectiveness of alternatives in maintaining protection of human health and the environment after response objectives have been met.

- Reduction of toxicity, mobility, and volume through treatment - The assessment against this criterion evaluates the anticipated performance of the specific treatment technologies an alternative may employ.

- Short-term effectiveness - The assessment against this criterion examines the effectiveness of alternatives in protecting human health and the environment during the construction and implementation of a remedy until response objectives have been met.

- Implementability - This assessment evaluates the technical and administrative feasibility of alternatives and the availability of required goods and services.

- Cost - This assessment evaluates the capital and O&M costs of each alternative.

This document does not address state or community acceptance. These modifying criteria are considered once the technical aspects of the alternatives are evaluated and have been presented to the public. At that time the public shall be asked to comment on the proposed remedial action. The public comments will be considered prior to any final decision on remediating the site. A brief description of the modifying criteria are as follows:

- State acceptance - This assessment reflects the state's apparent preferences among or concerns about alternatives.

- Community acceptance - This assessment reflects the community's apparent preferences among or concerns about alternatives.

## 3. GENERAL OVERVIEW OF RISKS

Summaries of Risk Assessments performed for the site can be found in Section C of this report.

In general, options that entail removal or destruction of contaminants from site media will permanently remove some portion of the risk. Options that involve containment or fixation will decrease risk as long as the contaminants are immobilized. If the contaminants are re-mobilized in the future prior to degradation, the risk reduction may not be permanent. Other options, such as institutional controls, may target exposure pathways without reducing the amount of contaminants present at the site. The effectiveness of these controls depends on their effectiveness at cutting the exposure pathway and the potential for contaminant migration.

Examining the contaminants of concern (See Table B-3), their concentration, occurrence (frequency of detection), and chemical properties, yields information which can be used to estimate general risks of each option. The contaminants of concern include chlorinated compounds, hydrocarbons, pesticides, PAHs, metals, coal tar, PCBs, and small amounts of phenolic compounds.

When examining the chemicals of concern, broad chemical concepts apply. All the chemicals, except metals, have high chemical bonding affinity for the coal tar. Most of these chemicals, except metals, are insoluble in water. The higher molecular weight organic compounds have low vapor pressure meaning they will not be airborne. Finally, most of the chemicals have low Henry's Law constants, meaning low ability for vapors to separate from the water phase. Inhalation exposure risks to workers and the public will be low. Engineering controls, such as keeping sediments wet, can further decrease inhalation exposures. Hydraulic removal or mechanical removal would be the safest removal options as far as airborne exposures are concerned.

If contaminants are dewatered, volatiles may be given off more readily, along with contaminated dust, resulting in higher inhalation exposures and exceedances of Lower Explosive Limits (LEL), especially in confined spaces. For example, when the coal tar is agitated, a moth ball-type odor (naphthalene TLV=10 ppm) is released. Coal tar products contain sulfur compounds that can degrade, potentially releasing hydrogen sulfide. Thus, there may be a potential for the release of hydrogen sulfide gas (TLV = 10 ppm) during remediation activities.

Soils handling is a major component of nearly all of the proposed options for treating contaminated soil. Soil handling activities include excavation, transportation or hauling, storage, and grading the treated or replaced soil. Any or all of these activities can result in fugitive dust, the main type of release from soil handling (See OWSER Directive 9285.7-01C, Interim Risk Assessment Guidance for Superfund: Volume I - Human Health Evaluation Manual; Part C, Risk Evaluation of Remedial Alternatives, December 1991, p.43).

Dermal exposures can be prevented by avoiding contact by using engineering controls (e.g. mechanical material handling), frequent decontamination of equipment (inside and outside), strict personal hygiene, and by the use of personnel protective equipment (PPE).

The remediation alternative selected will impact the health and safety issues that must be addressed. These issues will include risks posed by soil handling, the specific remedial technology, and final disposition of treated material. For instance, dewatering and excavation may cause contaminated dust, volatile, or confined space hazards. A specific remediation technology, such as on-site incineration, will have specific issues associated with its performance. Incineration will then impact the final disposition based on the effectiveness of combustion. Each technology, removal, remediation, and final disposition, will have separate short-term effectiveness and combined system effectiveness.

## 4. EVALUATION OF REMEDIAL ALTERNATIVES

### a. ALTERNATIVE 1: No-Action

1) Description:

The no action alternative consists of leaving the site and the coal tar in its present condition.

2) Overall Protection of Human Health and the Environment:

This Alternative would not protect human health and the environment. Potential exposure pathways and direct contact with and ingestion and inhalation of impacted sediments would exist and potentially increase over time. Exposure to COCs and the size of the affected area could increase over time as a result of disturbances by humans and natural processes and the subsequent movement of COCs by erosion and surface water transport.

3) Compliance with ARARs

ARARs are requirements that must be met or waived if remedial action is to be taken. Alternative 1, no action, would not attain COC-specific ARARs; action- and location-specific ARARs would not be invoked for the no-action alternative.

4) Long-term Effectiveness and Permanence

This alternative includes no control for exposure to COCs and no long-term management measures. All current and potential future risks remain. The human health risk associated with the no-action alternative results from COCs remaining in place at the site.

5) Reduction of Mobility, Toxicity, or Volume through Treatment

There is no treatment to reduce mobility, toxicity, or volume of the contaminated sediment.

6) Short-term Effectiveness and Environmental Impacts

Since no action would be taken, implementing this alternative would not directly cause adverse impacts on soils and geology, air quality, water resources, or biotic resources. However, no action allows waste sediments to remain. Continued exposure to COCs remaining in place may adversely affect urban biota on the site and any fauna feeding upon them. Baseline risk to ecological receptor is summarized in Section C.

7) Implementability

Implementability is not a concern since no action would be taken.

8) Cost

Since no action would be taken, no costs would be incurred under this alternative.

**b. ALTERNATIVE 2: Re-routing and Containment**

1) Description:

a) Background Data: Basic hydraulic study for the Floodplain Insurance and designated floodway mapping were obtained from the Federal Emergency Management Administration, FEMA, for the Chattanooga Creek Basin. Historic Aerial Photography from the Interim Report performed by the Bionetics Corporation, Warrenton, Virginia was furnished for COE information and use. The photography was used to locate and plot the known or suspected contaminated sites on the floodplain mapping obtained from FEMA.

b) Channel Alignment Corridor: A review of the aerial photography, used for the contaminant site plotting, indicated very little meandering of the channel from 1942 through 1978. Although, there are several residual scars and oxbows visible on the photography, it appears that these features are historic and associated with other periods prior to 1942. The photos do indicate that man-made cutoffs have occurred during this time period. The photos also indicate that the thread of the existing stream appears to be well entrenched and fairly stable. The valley and stream cross-sections taken from the FEMA hydraulic study also indicate that geologic control is in existence throughout various subreaches.

c) Alignment Criteria: The channel alignment chosen for this review used the existing channels and bridge at Hamill Road; had minimal intersections or crossings with the existing channel; as well as maintaining the greatest maximum distance from the known or suspected potential contaminated sites. The channel alignment finally chosen is shown on Figures E-1a and E-1b.

d) Hydraulics: Existing Chattanooga Creek: A hydraulic analyses was performed using existing conditions from the FEMA study in order to obtain water surface elevations, subreach lengths, and channel velocities. The existing study data will be used for comparison and review against the hydraulic analyses for the relocation of Chattanooga Creek. The study was initiated at the confluence with the Tennessee River and continued upstream and beyond Hamill Road bridge. The discharges used for this study and obtained from the FPMA study for Chattanooga are as follows:

| Frequency of Event | Discharge in cfs |
|---|---|
| 2 yr | 3800 |
| 10 yr | 6800 |
| 50 yr | 9600 |
| 100 yr | 11500 |
| 500 yr | 13300 |

Only the data for the 100-year event are included in this report and Table E-2 present the pertinent information. The data as listed begins just upstream of the Norfork and Southern Railroad bridge and the confluence with Dobb's Creek and then continues throughout the study reach to just above the Hamill Road Bridge.

e) Realignment Study: The hydraulic analyses for this realignment used a 50 foot channel bottom width and 2 on 1 side slopes with the bed elevation set nearly identical to the existing. The old channel was assumed to be filled to the existing ground elevation. Further, a roughness coefficients of 0.045 was used assuming that the channel bed and backslopes would be stabilized and protected with local rock as riprap which would possibly prevent future channel migration. The results of this study's 100-year event is also shown on Table E-2.

f) Channel Bed Control: Because of unknowns along the channel realignment, i.e., subsurface geology and soil characteristics, other considerations are suggested for inclusion. The study relocation of the channel will shorten the overall natural reach length between Dobb Creek and Hamill Road by about 5250 feet. The shortened length will increase the overall channel bed slope from 0.0005 to 0.0008 ft. per ft. thus adding about 2.7 feet of potential energy for conversion into kinetics by runoff events. Each runoff event will use this additional available energy to re-establish an equilibrium condition with it's local environment by bed degradation and bank erosion. In order to prevent future bed degradation by headcutting, possibly inducing meandering, bank undermining, and/or undermining the toe of the assumed riprap slope protection, a minimum of one grade control structure should be constructed at the location shown on Figure E-1b. The structure should be designed to have a drop in bed elevation at least 1.0 foot and preferable 1.5 feet.

g) Results: The channel size, relocation and roughness coefficient selected increased the water surface for the 100-year event by 0.5 ft above Hamill Road bridge. A slight increase in channel width immediately above the initiation of the relocation would be sufficient to lower all water surface profiles throughout the study reach rather than just above Hamil1 Road. This slight modification in channel width would prevent the necessity of performing a new FEMA study, changing the designated floodway, and preparing new flood insurance maps for other locations in Chattanooga Creek, i.e., other than the reach under this investigation.

h) Solidification: In addition to realignment of the channel, the coal tar deposits and contaminated sediments in the existing channel would be solidified with and mixtures such as cement. After solidification, the channel would be filled with the soil excavated from the new channel. In areas were the existing channel will form part of the new channel, the contaminated sediment will be removed and transported to a portion of the channel that will be filled. Since the new channel is somewhat shorter than the existing channel, additional fill may need to be imported from off-site areas.

i) Environment: This option would require removing 19.6 acres of vegetation for construction of the new channel, 1.0 acre for a pipeline corridor, 8.7 acres for access/haul roads, and 10.9 acres for storage of material excavated from the new channel. This option will require a total of approximately 40 acres of riparian lands. Because construction will occur in and adjacent to the creek, the majority of the 40 acres removed will be the palustrine forested wetlands as indicated by the Chattanooga Creek Wetland Inventory Map.

2) <u>Overall Protection of Human health and the Environment</u>

Re-routing the stream will prevent migration of the contaminants into the Chattanooga Creek. However, the contaminants will still remain in the former creek bed. The stabilization process has not been shown to be effective for preventing the migration of organics from the treated matrix; therefore, the potential for off-site migration still exists. The public may be prevented from direct contact with the contaminants but because the migration of contaminants could occur over the long-term, human health and the environment may not be protected.

3) <u>Compliance with ARARs</u>

Action-Specific ARARs - action-specific ARARs that may apply to this option include the following:

- Discharge of Dredge or Fill Material to Waters of the U.S.: 40 CFR 230. Clean Water Act of 1977, Section 401(b)(1) Guidelines for Specification of Disposal Sites for Dredged or Fill Material. Corps of Engineers, Regulations regarding Navigation and Navigable Waters, 33 CFR 320-330.

- Excavation: 40 CFR 268. (Subpart D), Protection of the Environment: Land Disposal Restrictions.

- Dredging:
  1) Closure with No Post-Closure Care.40 CFR 264.111. Protection of the Environment: Standards for owners and operators of hazardous waste treatment, storage and disposal facilities
  2) Closure with Waste in Place. 40 CFR 264.228(a)(2), 264.258(b), 264.310, 264.280. Protection of the Environment: Standards for owners and operators of hazardous waste treatment, storage and disposal facilities.

Chemical-Specific ARARs - chemical specific ARARs that may apply to this option include:

- EPA and State Water Quality Standards.
- EPA and State Air Quality Standards

Location-Specific ARARs - location specific ARARs that may apply to this option include:

- Artifacts: National Historic Preservation Act
- Critical Habitat: Endangered Species Act of 1973, Fish and Wildlife Coordination Act, and 33 CFR 320-330.
- Wetlands: Clean Water Act of 1977, 40 CFR 230, 40 CFR 6, 33 CFR 320-330, Executive Order 11990
- Floodplain Management: Executive Order 11988

4) <u>Long-term Effectiveness and Permanence</u>

Re-routing the stream through uncontaminated soils would prevent migration of the contaminants into the Chattanooga Creek. However, stabilization is not a destruction technology; therefore, it may not be a permanent solution for the PAH-contaminated material. The PAH's would still be present in the stabilized (contained) matrix. Furthermore, since stabilization is not a proven, effective technology for organics, the PAH's could migrate off-site. The degree of effectiveness would require formulation of some standard (for example, leachability of contaminants from the solidified matrix) in order to determine its effectiveness. A five year review of the Record of Decision would have to be performed.

Regarding adequacy and reliability of controls, it is not likely that stabilization will meet the required process efficiencies or performance specification.  Long-term management and surveillance (monitoring) of stabilized areas would be required to determine if migration in water or soil had occurred.

Operation and maintenance requirements would be slight except for posted signage.  Operations and maintenance requirement would have no anticipated difficulties or uncertainty.

If the contaminants are released from stabilized matrices additional remediation may be required such as re-stabilization or landfilling.  The magnitude of risk and degree of uncertainty associated with land disposal of residual and untreated wastes, would have to be addressed in the Part C risk assessment.

A variety of native seedling trees could be planted to replace mature trees that are removed for construction purposes such as access, haul roads and pipeline corridors.  A tree takes many years to reach maturity, and therefore several seedling trees are usually planted to mitigate for the loss of a larger tree.  A selected variety of native shrubs are also interspersed among the trees planted.  Haul roads and pipeline routes can in most instances be slightly altered to avoid larger trees and valuable specimens.  The mitigation/planting plan selected should consist of a variety of native tree, shrub, grass and wildflower plantings that would enhance the present environment and be compatible with Chattanooga's Masterplan.

5) Reduction of Toxicity, Mobility or Volume through Treatment

While there may be a decrease of mobility of contaminants, organics may leach out of the stabilized material over time, allowing transport of the contaminants off-site.  Because there is no destruction of contaminants, the toxicity is not reduced.  Stabilization of contaminated sediments will result in an increase in volume due to the addition of the binder.

6) Short-term Effectiveness

Containment is not a destruction technology and organic compounds are difficult to immobilize. Consequently, this technology is not suited for organic compounds (PAHs) or other easily leachable compounds, such as metals in a proper pH environment.  For example treatment with flyash will generate fugitive emissions and the volatile organics may not be bound well in the resulting matrix.  Treatment studies would be necessary to assess these potential problems.

Due to stabilization processes, fugitive emissions of vapors and particulates may be present. Surveillance of emissions, action levels to protect workers and the public, and community notification would be covered in the environmental monitoring and emergency response plans.

The aquatic environment of the natural channel would be permanently eliminated, however, the environment of the new channel would be reseeded and colonized with benthic aquatic organisms from upstream reaches and the more mobile vertebrate species would also recolonize as the recreated "natural" habitat progressively became more productive. Efforts should be made to locate the channel so the aquatic environment of the wetland riparian overbank areas and palustrine wetlands are not lost. If this is not possible they could be mitigated. The rerouted channel alignment could potentially take various configurations to provide the type of environment desired. Construction of the desired aquatic, wetlands and riparian habitat would depend upon topography and the possibility of the other unknown deposits of hazardous materials.

The particular type of rerouted channel as shown on the mapping would be shorter and have smoother bends and uniform features, and would have drop structures to couteract the bed degredation which would result from the shortened channel. These drop structures would prohibit fish passage. A uniform channel would in all probability, provide little usable aquatic fish and wildlife habitat, have a negative effect on the wetlands of the area, and essentially have aesthetically unappealing characteristics which would be incompatible with Chattanooga's Masterplan. Because the cleanup and revitalization of the area is part of the Chattanooga Masterplan, mitigation of the Chattanooga Creek channel and substrate could require that the hydraulic gradient be similar to the natural stream, that aquatic habitat in the form of rock and gravels and riffle areas be replaced in certain locations to replace that removed, as well as the placement of habitat by anchoring log and branch snags in select areas of the channel. Whatever channel configuration, hydraulic gradient and habitat improvements are determined to be required, they would be compatible with the needs of the Chattanooga Masterplan and then the appropriate mitigation needs implemented accordingly.

7) Implementability

Initial conceptual designs indicate that it is technically feasible to re-rout the Chattanooga Creek channel. Contractors, equipment and vendors are available which could provide the required services.

Containment of organic contaminants by conventional stabilization methods is not a proven technology, in fact it may not be a viable technology, particularly for the coal tar deposits. Various binders have been utilized in an attempt to stabilize organic contaminants; however, it has not been proven to be effective. Vendors and services for in-situ stabilization are available.

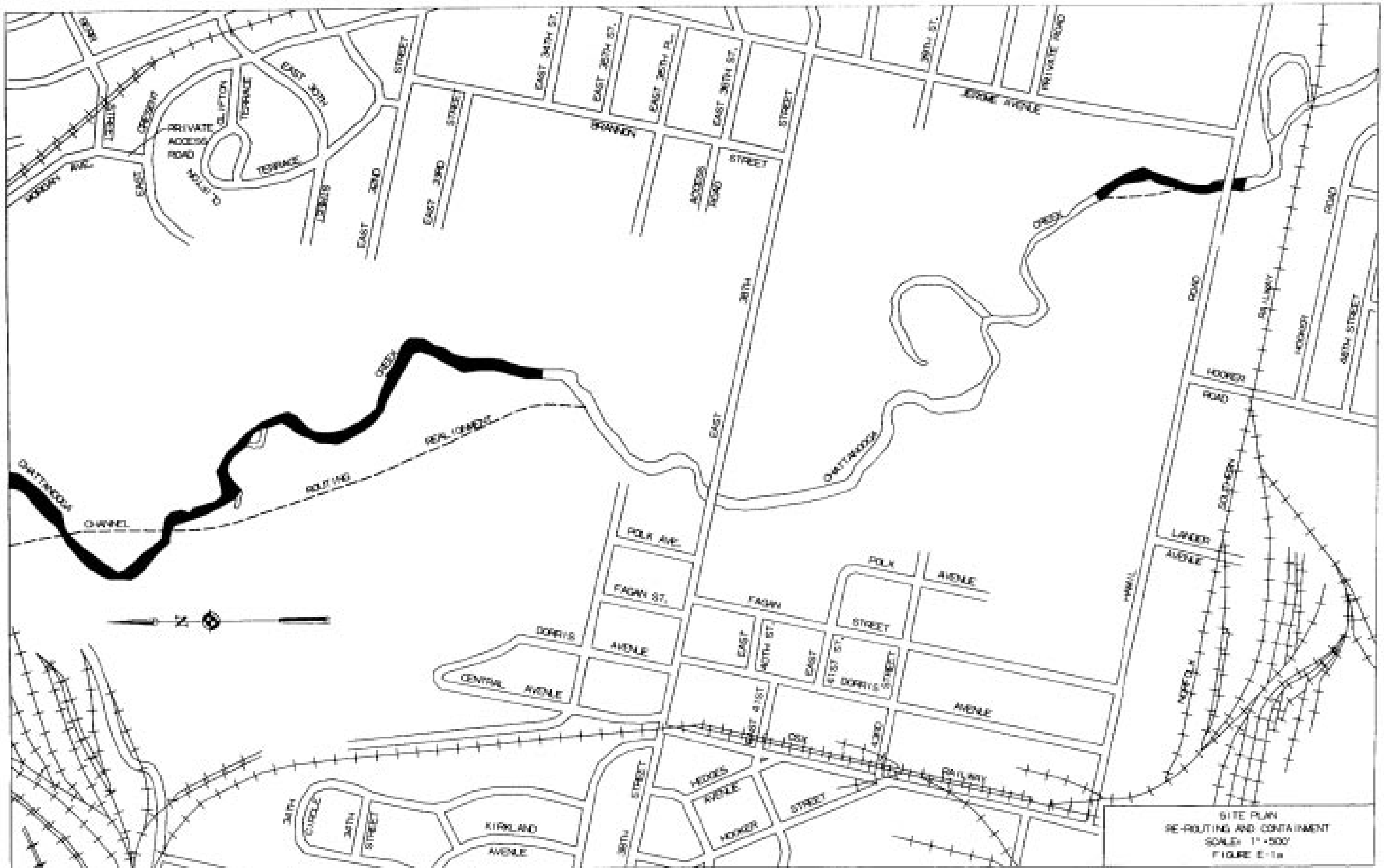
Although an attempt was made to avoid known contaminated areas with the re-routed channel shown, due to the nature of the area, it is possible contaminated soil may be found along this route. Extensive sampling would have to be performed along any rout proposed to ensure contaminated areas will not be intercepted during construction.

Other potential problems include the need for extensive real estate acquisition and possible relocation of utilities.

8) Costs

The estimated cost for this option is based on construction of a new channel for the majority of the creek length and removal of contaminated sediments in portions of the channel that remain. Also included is solidification of the contaminated sediments and deposits in the existing channel prior to backfill. A detailed breakdown of the estimate is provided in Appendix B. A summary of the major cost items is given below:

| **ITEM** | | **QUANT.** | **UNIT** | **UNIT COST** | **TOTAL COST** |
|---|---|---|---|---|---|
| 01 | Clearing and Grubbing | 28 | acres | 7193.57 | 201,400 |
| 02 | Install and Remove Haul Roads | 17,600 | LF | 48.36 | 851,200 |
| 03 | Cofferdam | 200 | LF | 1196.32 | 239,300 |
| 04 | Creek Diversion | 3,400 | LF | 179.37 | 609,800 |
| 05 | Channel Excavation | 3,700 | CY | 18.22 | 67,400 |
| 06 | Realignment Excavation | 92,400 | CY | 10.34 | 955,400 |
| 07 | In-situ Stabilization | 14,200 | CY | 188.00 | 2,669,600 |
| 08 | Slope Protection | 12,200 | tons | 30.41 | 371,100 |
| 09 | Backfill | 92,400 | CY | 7.03 | 649,700 |
| 10 | Sampling and Analysis | | LS | | 47,900 |
| 11 | Site Restoration | | LS | | 45,100 |
| **TOTAL FEASIBILITY ESTIMATE** | | | | | **$6,707,900** |




E-17

E-17

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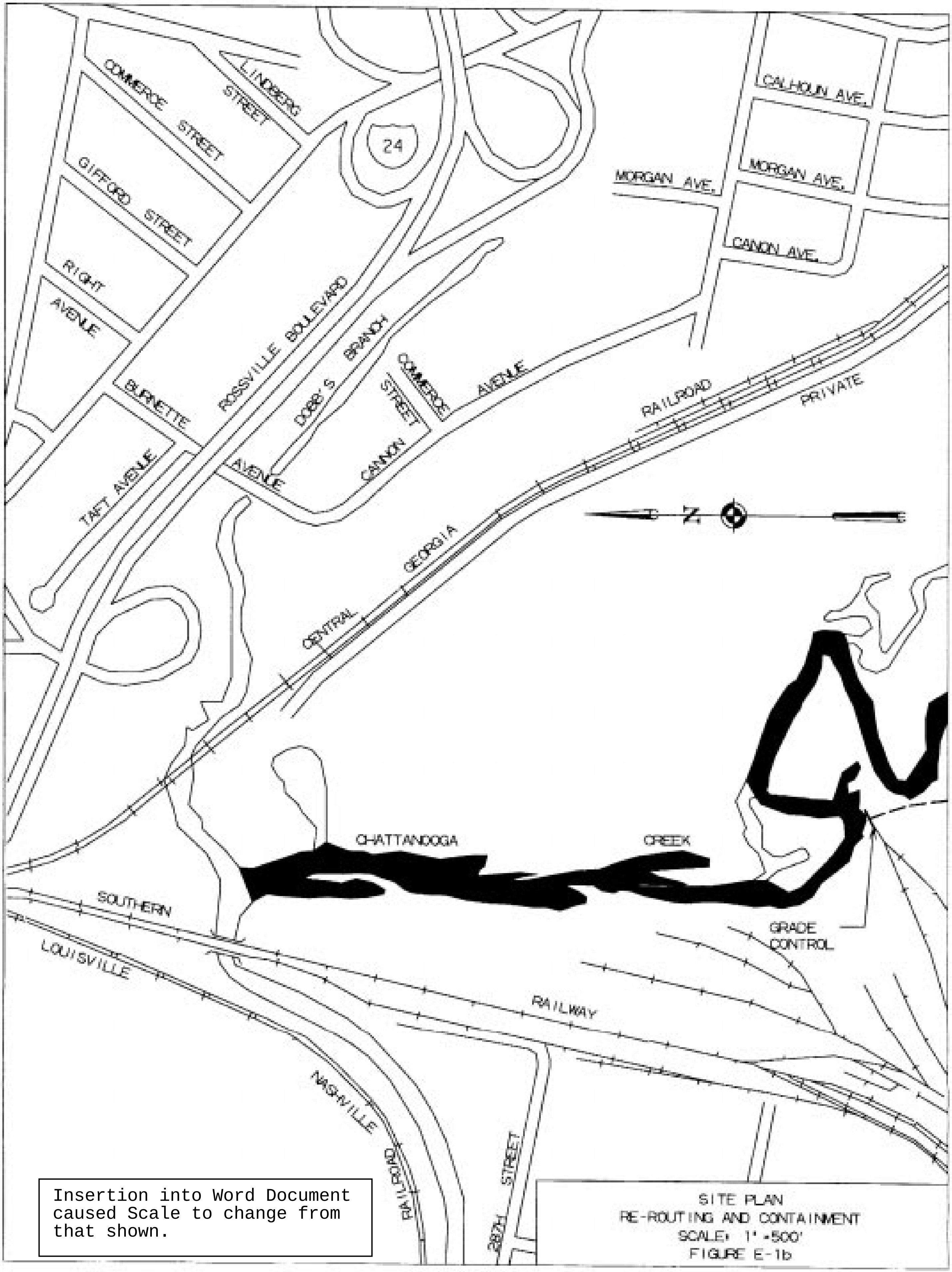
to fit into Word Document.
Not to Scale.

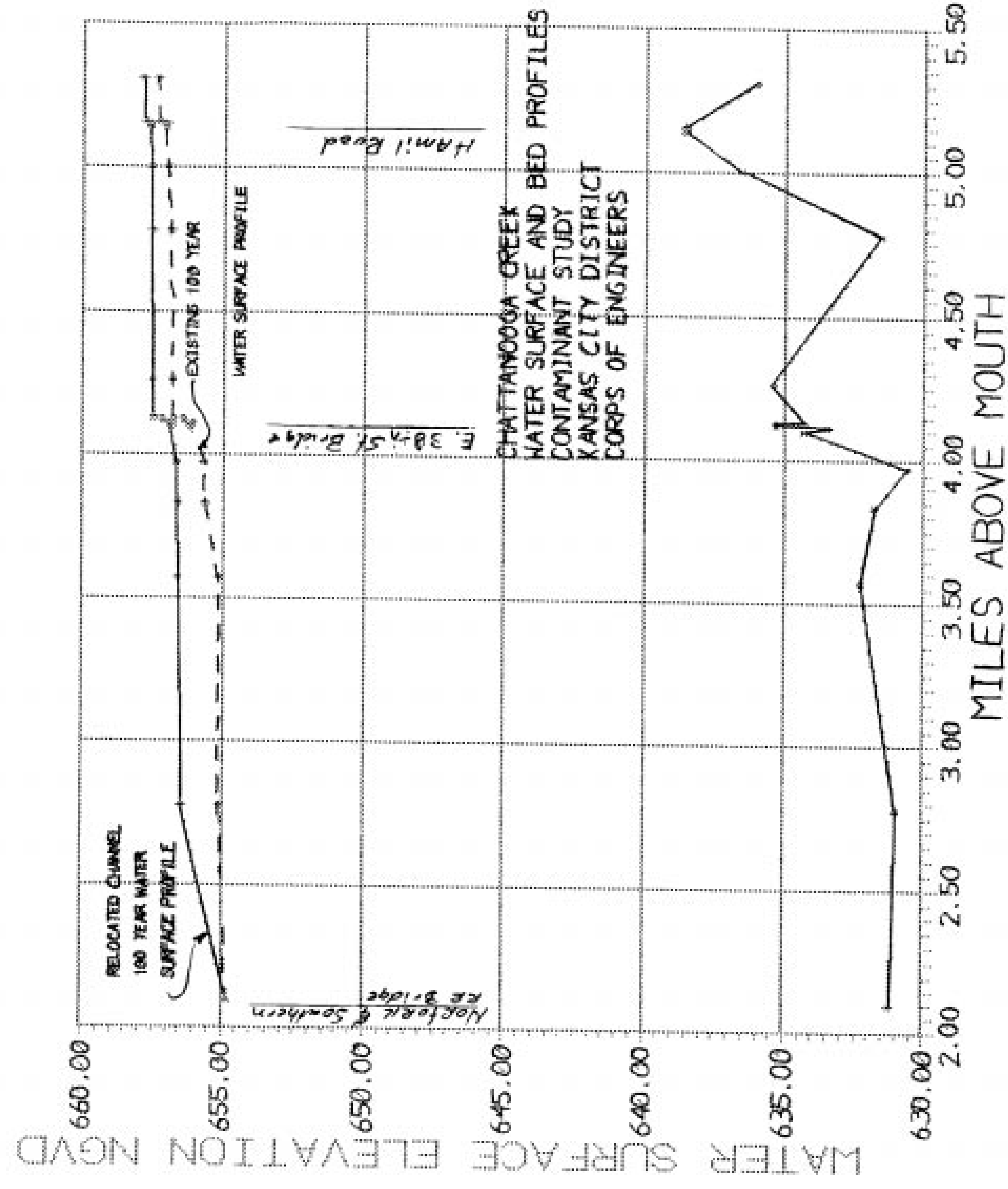



Insertion into Word Document caused Scale to change from that shown.

SITE PLAN
RE-ROUTING AND CONTAINMENT
SCALE: 1"=500'
FIGURE E-1b

## TABLE E-2: CHATTANOOGA CREEK, 100-YEAR EVENT

| LOCATION | EXISTING | | | RELOCATION | | |
|---|---|---|---|---|---|---|
| **STATION IN MILES** | **REACH LENGTH in feet** | **WATER SURFACE NGVD** | **VELOCITY in ft/sec** | **REACH LENGTH in ft** | **WATER SURFACE nvgd** | **VELOCITY in ft/sec** |
| 2.09 | | 654.79 | 2.12 | | 654.79 | 2.12 |
| 2.78 | 3530 | 655.12 | 1.46 | 2230 | 656.41 | 2.61 |
| 3.57 | 4000 | 655.12 | 1.72 | 1980 | 656.56 | 1.68 |
| 3.83 | 1280 | 655.60 | 1.62 | 580 | 656.58 | 1.77 |
| 3.97 | 740 | 655.68 | 4.93 | 680 | 656.62 | 3.96 |
| 4.10 | 610 | 656.14 | 3.81 | 610 | 656.86 | 2.29 |
| 38TH ST | 50 | 656.18 | 4.94 | 50 | 656.83 | 4.68 |
| DSBRIDGE | 5 | 656.08 | 5.84 | 5 | 656.80 | 5.72 |
| USBRIDGE | 61 | 656.18 | 5.90 | 61 | 656.94 | 5.72 |
| AB23RD ST | 5 | 656.41 | 4.55 | 5 | 657.17 | 4.37 |
| AB23RD ST | 15 | 656.76 | 1.10 | 15 | 657.49 | 1.33 |
| 4.26 | 764 | 656.79 | 1.34 | 720 | 657.52 | 1.46 |
| 4.78 | 1460 | 656.87 | 1.44 | 1300 | 657.56 | 1.62 |
| 5.0 | 1180 | 656.98 | 1.94 | 530 | 657.59 | 2.14 |
| 5.14 | 730 | 657.06 | 1.94 | 400 | 657.63 | 2.11 |
| HAMILL RD | 50 | 657.07 | 1.58 | 50 | 657.63 | 1.69 |
| DSBRIDGE | 5 | 657.04 | 4.00 | 5 | 657.61 | 3.79 |
| USBRIDGE | 30 | 657.16 | 3.89 | 30 | 657.68 | 3.73 |
| ABHAMIL RD | 5 | 657.31 | 1.54 | 5 | 657.81 | 1.66 |
| ABHAMIL RD | 15 | 657.31 | 1.89 | 15 | 657.81 | 2.07 |
| 5.31 | 695 | 657.38 | 1.80 | 695 | 657.88 | 1.70 |



WATER SURFACE ELEVATION NGVD
660.00
655.00
650.00
645.00
640.00
635.00
630.00
MILES ABOVE MOUTH
2.00
2.50
3.00
3.50
4.00
4.50
5.00
5.50
CHATTANOOGA CREEK
WATER SURFACE AND BED PROFILES
CONTAMINANT STUDY
KANSAS CITY DISTRICT
CORPS OF ENGINEERS
RELOCATED CHANNEL
100 YEAR WATER
SURFACE PROFILE
EXISTING 100 YEAR
WATER SURFACE PROFILE
Norfolk & Southern RR Bridge
E. 38th St. Bridge
Hamil Road




FIGURE E-2

### c. ALTERNATIVE 3: On-Site Landfilling

1) Description:

On-Site landfilling would include containment of the coal tar deposits and contaminated sediments from the creek in a landfill meeting the requirements of Subtitle C of RCRA. The landfill would be located at the Chattanooga Coke and Chemical Company site. Although on-site land disposal may form a part of an on-site treatment option, this option will evaluate on-site landfilling with solidification/stabilization as the only treatment prior to deposition of the material in the landfill.

The components of a Subtitle C are a double liner with leachate collection and leak detection system and a final cover. A typical double liner may include a compacted low permeability clay layer, a 40 mil FML, a leak detection layer constructed of granular fill or synthetic drainage media, a 60 mil FML, a leachate collection layer constructed of granular fill or synthetic drainage media, and a protective cover. A typical cover would consist of a low permeability clay layer or geosynthetic clay layer, a 40 mil FML, a cover drainage layer, and 2-foot common/topsoil layer (See Figure E-3).

The footprint area of the landfill will depend upon the maximum desired height and available space on the Chattanooga creek and the former coke plant site. Assuming 14,200 $YD^3$ of waste and a 100% volume increase from solidification, the total volume of waste requiring disposal is approximately 28,400 $YD^3$. Assuming a maximum landfill height of 20 feet above the ground with 3 to 1 interior slopes on the embankment surrounding the landfill and maximum slopes of 5% for the cover, the total area of the landfill footprint would range from 1.5 to 2 acres.

2) Overall Protection of Human Health and the Environment:

This option provides protection of human health and the environment by isolating the wastes from the surrounding environment and thus reducing the potential exposure pathways. Risks will be reduced at the site unless some portion of the containment system fails. Since this option does not destroy the contaminants through treatment, a five year review of the Record of Decision will be required to evaluate continued effectiveness. Institutional controls such as long-term monitoring of groundwater and leachate will be required as well as overall maintenance to ensure the continued effectiveness of the containment system.

3) <u>Compliance With State and Federal Regulations:</u>

Action-Specific ARARs - the action-specific ARARs provided by EPA that may apply to this option include the following:

- Placement of Liquid Waste in Landfill: 40 CFR 264.314
- Placement of Waste in Land Disposal Unit: 40 CFR 268 (Subpart D)
- Capping Landfills: 40 CFR 264.310(a)

Chemical-Specific ARARs - This option will not meet chemical-specific ARARs unless some form of treatment is performed prior to landfilling. It will reduce exposure and mobility of the contaminants through containment.

Location-Specific ARARs - location-specific ARARs that may apply to this option include:

- Siting of Landfill: 40 CFR 264, Subpart B
- Seismic and Floodplain: 40 CFR 264.18

4) <u>Long-term Effectiveness:</u>

This option will substantially reduce the risks at the site unless some portion of the containment system fails. There are risks of liner failure, cap failure, or leachate collection system failure which will increase with time. Since this option does not remove or destroy contaminants, a five year review of the Record of Decision will be required to evaluate continued effectiveness. Pre-treatment of volatiles from Chattanooga Creek coal tar deposits may be an option which would permanently reduce risks from that landfill.

The contaminated sediments may require solidification to increase their strength and reduce potential settlement prior to landfilling. Solidification is also effective at reducing the leachability of metals but is not effective at reducing the leachability of volatile organics. Organics in the contaminated sediments may hinder hydration of the solidified material.

Long-term management of the landfill will be needed to maintain effectiveness to include maintenance, groundwater monitoring, and gas and leachate analysis to assess performance.

It is difficult to evaluate potential risks that may occur if the landfill fails due to a breach in the cap, liner, or leachate collection system. The landfill will give a medium degree of confidence that it can handle potential problems. The uncertainties associated with land disposal of residuals and untreated wastes are high beyond the life of the landfill.

5) Reduction of Contaminant Toxicity, Mobility, and Volume:

The landfilling option combined with preliminary solidification of the waste will result in an increase in the total volume of the waste. Landfilling will reduce the mobility of the contaminants through containment. Solidification will act to reduce the mobility of the metals but will have little effect on the reducing the mobility of the PAHs. This option does not meet the statutory preference for employing treatment technologies that permanently and significantly reduce toxicity, mobility, or volume of the hazardous substances as their principle element.

6) Short-term Effectiveness:

Risks to the community would involve minimal vapor hazards associated with waste hauling and placement of waste. There would be some runoff hazards from rain falling onto the landfill.

Risks to the community will be mitigated by a runoff control program, monitoring wells, perimeter air monitoring, and dust suppression techniques.

Hazards to workers are the same as the above, but are manageable with proper surveillance and engineering controls.

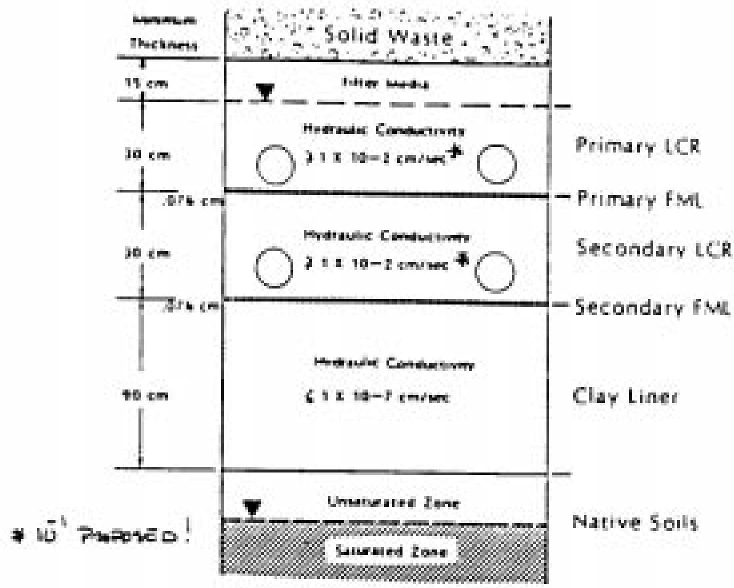
7) Implementability:

This option employs proven construction techniques and readily available equipment and materials. In fact, the location of the site is in close proximity to many of the major manufacturers of geosynthetic materials used in landfill construction. This may provide some additional economical advantages for this option.

8) Costs:

The estimated cost for this option is based on construction of an on-site landfill and solidification of 14,200 c.y. of sediments and coal tar deposits prior to placement into the landfill. It was assumed that solidification would cause a 100 percent volume increase which results in a required landfill size of approximately 370 ft x 185 ft. A detailed breakdown of the estimate is provided in Appendix B. A summary of the major cost items is given below:

| ITEM | | QUANT. | UNIT | UNIT COST | TOTAL COST |
|---|---|---|---|---|---|
| 01 | Excavation of Sediments | | LS | | 3,326,700 |
| 02 | Fencing | 1,190 | LF | 49.67 | 59,100 |
| 03 | Stabilization | 14,200 | CY | 136.43 | 1,937,300 |
| 04 | Landfill Liner | | | | 393,000 |
| 05 | Landfill Cover | | | | 342,200 |
| 06 | Excavation for Cell and Berm | 1 | each | 80700 | 80,700 |
| 07 | Place Treated Material in Landfill | 29,280 | CY | 5.15 | 150,900 |
| 07 | Seeding and Mulching | 2 | acres | 6614.29 | 13,200 |
| 08 | Operation and Maintenance | | | | 18,500 |
| **TOTAL FEASIBILITY ESTIMATE** | | | | | **$6,321,600** |




Profile of MTG Double Liner System

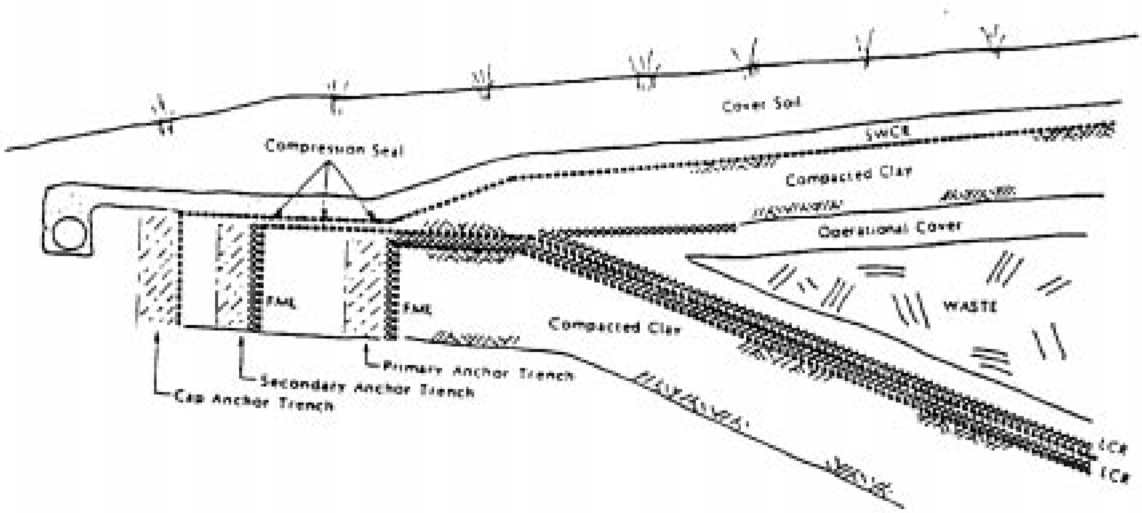
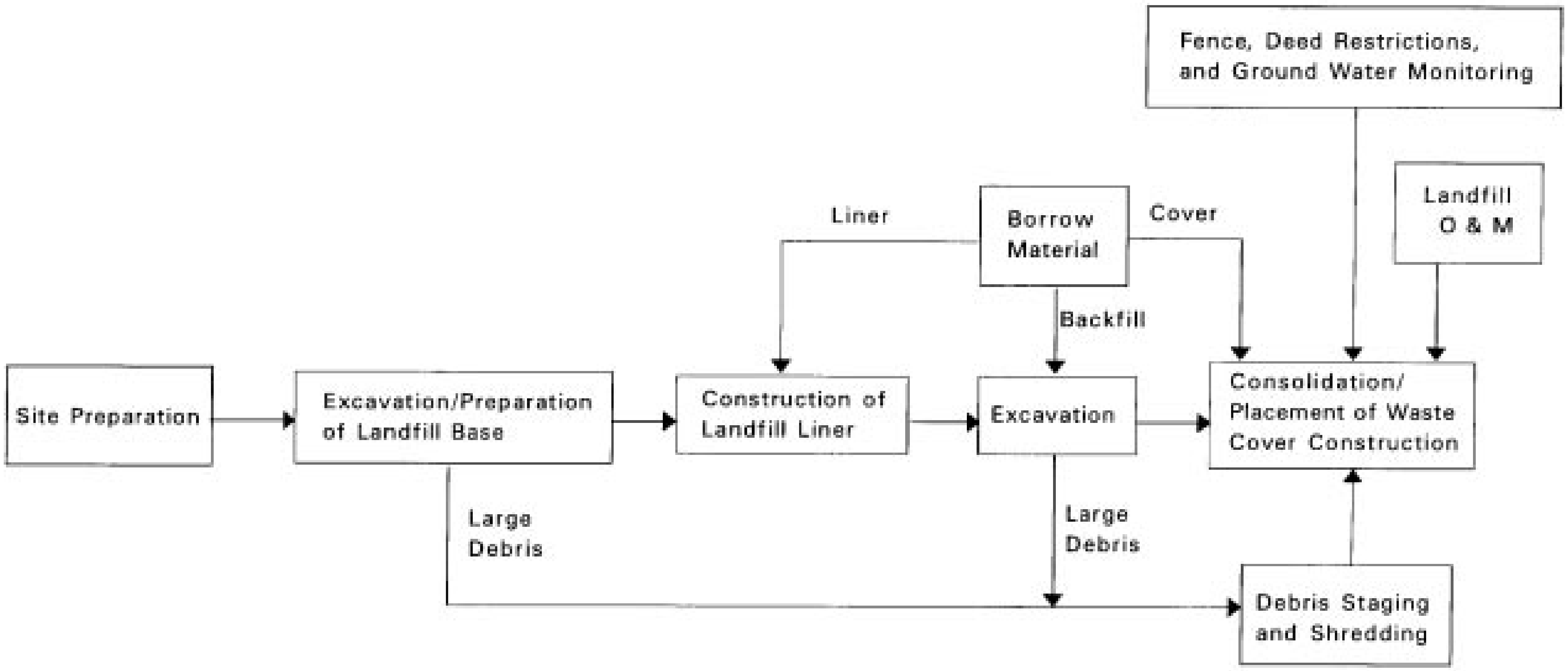



FIGURE E-3: Typical RCRA Subtitle C Landfill Section




Conceptual Process Flowchart for an On-site Landfill

FIGURE E-4

### d. ALTERNATIVE 4: Off-site Waste-To-Fuel

1) Description:

Off-site treatment and disposal was briefly described in Section D. This option would require the removal of contaminants, consolidation, off-site transportation, and treatment by an off-site treatment, storage and disposal facility (TSDF). The process residuals would then be recycled or landfilled at a TSDF.

Several off-site treatment options have potential applicability for the materials on this site. These include incineration, recycling of the coal tar deposits, and waste-to-fuel. Each option has limitations and would require investigation and treatability studies to select performance parameters and to ensure implementability. In addition, a certain amount of on-site pre-processing would be required for each off-site option; the extent of pre-processing necessary would be dependent upon the removal option selected and the specific requirements of each off-site treatment option. For example, some TSDF's would prefer to handle pumpable slurries and transportation by rail car while others may prefer handling a solid material. Some TSDF's have the flexibility to handle either form of waste and some are able to recover and reuse coal tar deposits. The Waste-To-Fuel option was successfully used during the 1997-1998 Early Removal Action. This off-site treatment is likely more implementable than the recycling option and less expensive than the off-site incineration option. Therefore, the FFS will focus the evaluation off-site treatment assuming the Waste-To-Fuel option.

Waste-To-Fuel

The waste-to-fuel option involves incorporating the waste from this site into fuel for coal-fired boilers. Vendor contact with a facility that converts coal tars and associated contaminated sediments to fuel, indicated that the deposits must be excavated, pretreated (if necessary), and shipped by rail car or truck. They can accept the waste as bulk solids. There are several material specific criteria that must be met to utilize this technology (for instance the bulk materials must have a heating value of greater than 5000 btu/lb); therefore, treatability studies and further evaluations of the site materials must be conducted to ensure the feasibility of this option. For the FFS, it was assumed the combined bulk material would have a heating value greater than 5000 btu/lb; mixing the coal tar deposits with the sediments if necessary to raise the heating value to the required level.

2) <u>Overall Protection of Human Health and the Environment</u>

This option does protect human health and the environment. Because the contamination is removed from the creek and adjacent areas, the potential for off-site migration of contaminants is eliminated. Furthermore, because all of the contaminants will be removed from the area, the threat to human health and the environment is reduced to acceptable levels.

3) <u>Compliance with ARARs</u>

General ARARs pertinent to this option include the following:

<u>Federal</u>

- Clean Air Act, CAA
- Public Health Service Act: Title XIV as amended by the Safe Drinking Water Act, SDWA
- Solid Waste Act, SWDA as amended by RCRA
- Hazardous Materials Transportation Act (HMTA)

<u>State</u>

- Have not been provided to COE from EPA, but may include the following general ARARs
- National Pollution Discharge Elimination System, NPDES
- Rules and Regulations governing the Pretreatment Program

The EPA has not previously designated the contaminants as a RCRA waste; therefore, RCRA will only become an ARAR in the event that some of the treated material and process residuals exhibit a hazardous characteristic as defined by RCRA. Any material that exhibits hazardous characteristics as defined by RCRA shall be handled accordingly.

Regulations covering the transportation of hazardous materials would also be an ARAR. These regulations include those outlined by the Department of Transportation (DOT) and may include interstate transportation requirements as well.

4) <u>Long-term Effectiveness and Permanence</u>

Magnitude of remaining risk will be according to the RAGS Part C risk assessment and the ecological risk assessment already underway. The magnitude of the remaining sources of risk can not be identified at this time. Also, that portion due to untreated residual and treated residuals will be determined in the future.

5) Reduction of Toxicity, Mobility, or Volume through Treatment

This option satisfies the statutory preference for treatment as a principal element. Furthermore, the coal tar deposits do have the potential for reuse after processing. Because none of the contaminated media above the action limits would be left at the site, the potential for mobility of contaminants is virtually eliminated. The volume of contaminated material would be greatly reduced because of the treatment of the coal tar deposits and the sediments. Because the contaminated material would undergo treatment, essentially all of the PAHs would be destroyed and the threat posed by them eliminated.

6) Short-term Effectiveness

Risks to the immediate off-site community would be limited to minimal vapor hazards associated with waste hauling and excavation. There might be some runoff hazards from rain falling on excavated areas.

Risks to the community will be mitigated by a runoff control program, perimeter air monitoring, and dust suppression techniques.

Hazards to workers are the same as the above, but are manageable with proper surveillance and engineering controls.

Most of the time required to implement this option would not be in shipping or treatment, but would be associated with removal of the sediments from the creek. It is estimated that approximately 6 months would be required for processing and consolidation of material prior to off-site shipping.

7) Implementability

The Waste-To-Fuel option was effectively used in the 1997-98 Removal Action at Chattanooga Creek. Therefore, it is assumed it will be equally successful for the portions of the creek addressed by the FFS. There is a possibility that the downstream portion of the creek, between Southern Wood Piedmont and Dobbs Branch may not be as highly contaminated as the portions remediated during the removal action. Therefore, blending with more contaminated sediments or supplementing the sediments with higher BTU value material may be required.

8) Costs

To cost estimate for off-site treatment using the Waste-To-Fuel option assumes 19,170 tons of contaminated sediments will be removed from the creek, processed, and transported in bulk to an off-site facility for use as fuel. A detailed breakdown of the estimate is provided in Appendix B. A summary of the major cost items is given below:

**WASTE-TO-FUEL**

| ITEM | QUANT. | UNIT | UNIT COST | TOTAL COST |
|---|---|---|---|---|
| 01 Excavation of Sediments | | LS | | $3,326,700 |
| 02 Waste-To-Fuel (Including Trans) | 19,170 | ton | 136.84 | $4,152,700 |
| **TOTAL FEASIBILITY ESTIMATE** | | | | **$ 7,479,400** |


Conceptual Process Flowchart for Off-Site Treatment

**e. ALTERNATIVE 5: On-site Incineration**

1) <u>Description:</u>

Incineration was previously described in Section D. It is one of the most widely used methods of remediation because of its effectiveness for a wide range of compounds. A conceptual process diagram illustrating the major components of this option is shown in Figure E-6. Note that the contaminants must be excavated or dredged, hauled to the site, dewatered, consolidated and treated. There are many different types of incineration such as fluidized-bed, multiple-hearth and others but the most commonly used mobile or transportable type of incinerator in use for incineration of solid media is a rotary kiln. The following evaluation of incineration is based upon a mobile or transportable, rotary kiln incinerator.

The main combustion chamber for this type of unit consists of a tilted rotating cylinder. Heat is applied by combustion of a fuel such as natural gas within the kiln. The contaminated sediments would be fed to the upper end of the unit and would travel via gravity due to the turning of the tilted rotating unit. Typically, much of the process is operated at sub-atmospheric pressures to prevent fugitive emissions. The solids residence time within the rotary kiln may range from 15 to 60 minutes. Temperatures from 1,200 to 1,800 °F are maintained in the kiln. The combustion gases are further treated in an afterburner, and then pass through particulate control and possibly other air pollution control equipment.

Without site-specific treatability studies the main assumption involved with any remediation technology is that it will in fact be implementable, cost-effective and meet all ARARs. If this were not the case then the technology would not have passed the initial screening phase. In the case of a proven technology such as incineration, this assumption is realistic. However, treatability studies for incineration are required to insure that this assumption is valid. The Appendix includes suggestions on data requirements for incineration.

Depending upon the removal option the percent moisture of the sediments could vary considerably. For this option it is assumed that dewatering of all of the sediments will be required. Dewatering could be accomplished via settling lagoons or by pressure filters followed by drying beds. Each of these methods have their own advantages and disadvantages. Dewatering will minimize energy requirements and could aid in material handling. However, an aqueous phase stream will also be generated. This stream will require treatment prior to discharge. It is assumed that dewatering lagoons followed by drying beds will be used here and that the settled sediments will be 60% solids (EPA Survey of Materials Handling Technologies).

The feed to the incinerator is assumed to be 60% solids. Typical transportable incinerators have feed rates from 7 - 15 tons/hr. The feed rate for this evaluation is assumed to be 7 tons per hour due to the probability of a high heat value for the coal tar deposits. The incinerator is also assumed to operate 75% of the time due to maintenance and other periods of down time.

2) Overall Protection of Human Health and the Environment

Incineration provides overall protection of human health through essentially complete destruction of the contaminants of concern. Protection of various ecosystems would also be provided due to the removal and treatment of the contaminants. Therefore, the risks associated with PAH's found in the source areas along Chattanooga Creek would be reduced to levels which are acceptable to the EPA for protection of human health and the environment.

3) Compliance with ARARs

ARARs pertinent to this option include the following:

Federal

- Clean Air Act, CAA
- Clean Water Act, CWA
- Public Health Service Act: Title XIV as amended by the Safe Drinking Water Act, SDWA
- Solid Waste Act, SWDA as amended by RCRA

State

- Have not been provided to COE from EPA; however, the following will probably apply
- National Pollution Discharge Elimination System, NPDES
- Rules and Regulations governing the Pretreatment Program

This option will be designed with controls to meet the Federal CWA and SWDA. The State regulations on surface water quality, NPDES and pretreatment must be met for decontamination water and for any potential process water which may require discharge. There will be some water generated from the dewatering operations that will probably require discharge. Systems will be designed to meet all of the associated ARARs.

The EPA has not previously designated the contaminants as a RCRA waste; therefore, RCRA will only become an ARAR in the event that some of the treated material and process residuals exhibit a hazardous characteristic as defined by RCRA. Any material that exhibits hazardous characteristics as defined by RCRA shall be handled accordingly.

Incineration emissions must abide by the CAA and meet the State ARARs on air quality. Engineering controls will be designed to insure that the process will meet ARARs related to emissions and air quality.

4) Long-term Effectiveness and Permanence

Magnitude of remaining risk will be according to the RAGS Part C risk assessment and the ecological risk assessment already underway. The magnitude of the remaining sources of risk can not be identified at this time. Also, that portion due to untreated residual and treated residuals will be determined in the future.

5) Reduction of Toxicity, Mobility, or Volume through Treatment

This option satisfies the statutory preference for treatment as a principal element. Incineration is a technology which in most cases must exhibit a 99.99 % destruction efficiency for the contaminants of concern. Therefore, the toxicity and mobility is virtually eliminated. The volume of treated material is expected to be only slightly less than or equal to the original volume; however, it is expected to be virtually free of PAHS. Therefore, the reduction in volume of contaminated material is nearly 100 percent.

Incineration can however, tend to concentrate metals; therefore, TCLP testing should be conducted to determine whether the concentration of metals is high enough to be a characteristic waste. A small fraction of the treated material may exceed TCLP limits for metals and will then require stabilization and off-site landfilling.

6) Short-term Effectiveness

Lockout/tagout measures in conjunction with emergency shutdown procedures are examples of important safety considerations associated with incineration. Cleanout of combustion chambers needs a set of standard operating procedures that prevent entry to hot combustion chambers which may be subject to falling hot debris.

Protection of the public and workers from stack emissions and fugitive emissions from volatile organics from feed sludges. There may also be a discharge of scrubber blowdown to water sources that needs to be prevented or mitigated by air pollution control devices. A plan to mitigate or prevent release of contaminant discharge to water sources shall also be present. Noise may also present as a hazard to workers and the community.

The on-site incineration includes many different sequential process steps including removal of the contaminated sediments, dewatering, incineration, testing of the treated material to insure compliance, and finally, placing the material on the Tennessee Products Site and covering the treated material with a one foot layer of top-soil. The time required to implement the required steps from dewatering to site restoration is approximately 15 months. This does not include the time required for the removal action.

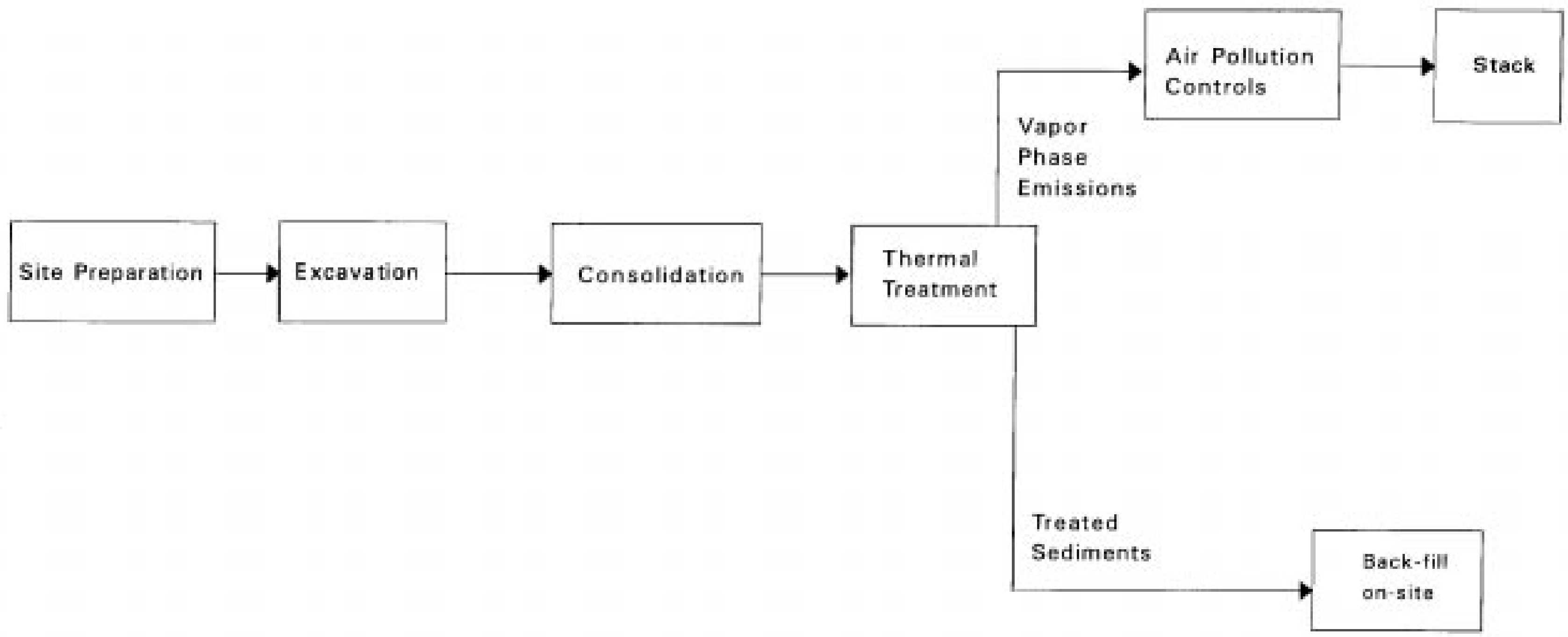
7) Implementability

Incineration is a proven technology which has been implemented at full-scale at many other sites with similar contaminants. Therefore, this option is technically feasible. On-site incineration is expected to meet any administrative and statutory requirements. Services and equipment for on-site incineration is readily available from many different vendors. Monitoring the effectiveness of incineration is accomplished through sampling of the treated material and through emissions testing.

8) Costs

The estimate for this option is based on treating the waste with a small on-site incinerator. Estimated costs include a trial burn and the sampling and analysis of stack emmissions and treated material. Also included is stabilization of 10% of the material to address the metals. A detailed breakdown of the estimate is provided in Appendix B. A summary of the major cost items is given below:

| **ITEM** | | **QUANT.** | **UNIT** | **UNIT COST** | **TOTAL COST** |
|---|---|---|---|---|---|
| 01 | Excavation of Sediments | | LS | | 3,326,700 |
| 02 | Incineration | 19,170 | ton | 372.43 | 7,139,500 |
| 03 | Sampling and Analysis | 1 | each | | 812,200 |
| 04 | Stabilization and Disposal | 1,420 | CY | 356.51 | 506,200 |
| 05 | Place Treated Material in Cell | 12,780 | | 2.85 | 36,500 |
| 06 | Imported Topsoil Cover, 2-ft | 8,067 | CY | 39.50 | 318,700 |
| 07 | Site Restoration | 3 | acre | 3867.55 | 11,600 |
| **TOTAL FEASIBILITY ESTIMATE** | | | | | **$12,151,400** |




Conceptual Process Flow-chart for On-site Incineration



FIGURE E-6

### f. ALTERNATIVE 6: On-site Thermal Desorption

1) Description

Thermal desorption is a process which heats contaminated media to temperatures which exceed the volatilization temperature of the contaminants. The contaminants then volatilize and this contaminated vapor stream is further treated, leaving clean, treated solids. Thermal desorption is a viable treatment method for removing organic compounds from soils, sludges, sediments and other media. Though this process is considered to be innovative, it has been used successfully at full-scale to treat contaminated soils and sludges.

The system typically consists of a thermal dryer which heats the soil for enough time at high enough temperatures to desorb and volatilize the contaminants from the solid or liquid phase into the vapor phase. The vapor phase is treated to remove the contaminants prior to discharge into the atmosphere. This can be accomplished by vapor phase carbon or thermal destruction depending upon the physical and chemical properties of the vapors and the ARARs. Figure E-7 shows a conceptual process flow diagram for thermal desorption.

In the absence of treatability study data, which are used to verify performance, the main assumption for this option is that it will indeed meet ARARs, be implementable and provide cost-effective treatment for the coal tar deposits and contaminated sediments. Successful pilot-scale studies have been conducted on similar contaminants; therefore, this assumption is valid for the purposes of performing a detailed evaluation on this option. Treatability studies should be conducted prior to proposing this technology for remediating the site in order to validate these assumptions and identify potential problems associated with this technology.

As with any treatment process, the efficiency, operating parameters and costs of thermal desorption are directly a function of what is being fed to the process. The previously discussed assumptions for dewatering the sediments for on-site incineration are also appropriate for this technology. Other assumptions have been listed in the Appendix.

The contaminated feed to the thermal desorption unit is assumed to be 60% solids. Thermal desorption units with soil throughput of up to 40 tons/hr are available; however, this throughput rate is a function of temperature. The temperature requirements for this site are higher than that required for many other sites; therefore, the soil throughput is assumed to be approximately 7 tons/hr. The thermal desorber is assumed to operate 75% of the time due to maintenance and other periods of down time.

2) <u>Overall Protection of Human Health and the Environment</u>

Thermal desorption provides overall protection of human health through nearly complete removal of the contaminants of concern from the contaminated media, followed by essentially complete destruction of the contaminants in the vapor phase treatment process. Protection of various ecosystems would also be provided due to the removal and treatment of the contaminants. Therefore, the risks associated with PAH's found in the source areas along Chattanooga Creek would be reduced to acceptable levels.

3) <u>Compliance with ARARs</u>

ARARs pertinent to this option include the following:

<u>Federal</u>

- Clean Air Act, CAA
- Clean Water Act, CWA
- Public Health Service Act: Title XIV as amended by the Safe Drinking Water Act, SDWA
- Solid Waste Act, SWDA as amended by RCRA

<u>State</u>

- Have not been provided to COE from EPA, but the following may apply:
- National Pollution Discharge Elimination System, NPDES
- Rules and Regulations governing the Pretreatment Program

All of the potential options must be engineered to meet the Federal CWA and SWDA. State regulations on surface water quality, NPDES and pretreatment must be met for decontamination water and for any potential process water which may require discharge. There will be some water generated from the dewatering operations that will probably require discharge which requires an NPDES permit.

The EPA has not previously designated the contaminants as a RCRA waste; therefore, RCRA will only become an ARAR in the event that some of the treated material and process residuals exhibit a hazardous characteristic as defined by RCRA. Any material that exhibits hazardous characteristics as defined by RCRA shall be handled accordingly.

Vapor phase emissions must abide by the CAA and meet the State ARARs on air quality. Engineering controls will be designed to insure that the process will meet ARARs related to emissions and air quality.

4) <u>Long-term Effectiveness and Permanence</u>

The magnitude of residual risk will be evaluated in the RAGS Part C risk assessment and the ecological risk assessment already underway. The magnitude of the remaining sources of risk can not be identified at this time. Also, that portion due to untreated residual and treated residuals will be determined in the future.

5) <u>Reduction of Toxicity, Mobility, or Volume through Treatment</u>

This option satisfies the statutory preference for treatment as a principal element. Thermal desorption pilot studies at similar sites have demonstrated a very high degree of removal of contaminants from contaminated soils and sludges, followed by nearly complete destruction of the resulting vapors. Therefore, the toxicity and mobility is virtually eliminated. The volume of treated material is expected to be approximately the same as the original volume; however, it is expected to be virtually free of PAHS. Therefore, the reduction in volume of contaminated material is nearly 100 percent.

There are some metals regulated under RCRA at the site and thermal treatment can concentrate these metals. TCLP testing should be conducted to determine whether the concentration of metals is high enough to be a characteristic waste. A small fraction of the treated material may exceed TCLP limits for metals and will then require stabilization and off-site landfilling.

6) <u>Short-term Effectiveness</u>

Lockout/tagout measures in conjunction with emergency shutdown procedures are examples of important safety considerations associated with thermal desorption. The hazards associated with caustic storage (chlorine scrubber) will need to be addressed in an emergency response plan. Caustic use will require special safety equipment, such as an eyewash, safety showers, safety goggles when working with caustic; and spill containment and countermeasures.

Protection of the public and workers from stack emissions and fugitive emissions from volatile organics from feed sludges. There may also be a discharge of scrubber blowdown to water sources that needs to be prevented or mitigated by air pollution control devices. A plan to mitigate or prevent release of contaminant discharge to water sources shall also be present. Noise may also present as a hazard to workers and the community.

The thermal desorption process is similar to the on-site incineration process in terms of requiring many different steps to complete the process. The time required to implement the required steps from dewatering to site restoration is approximately 13 months. This does not include the time required for the removal action. Assumptions made to calculate this treatment time are given in the Appendix.

7) Implementability

Thermal desorption is still considered to be an innovative technology despite the fact that it has been implemented successfully at Superfund sites. Treatability studies must be conducted to confirm the technical viability of thermal desorption; however, based upon previous studies at other sites, thermal desorption should be technically feasible. Due to the nature of the contaminants at this site (heavy tars), the rate of treatment may be slow to prevent fouling the interior of the kiln. This option is expected to meet any administrative and statutory requirements. Services and equipment for thermal desorption are readily available from several vendors. Testing the effectiveness of thermal desorption is easily accomplished through sampling of the treated material and through emissions monitoring.

8) Costs

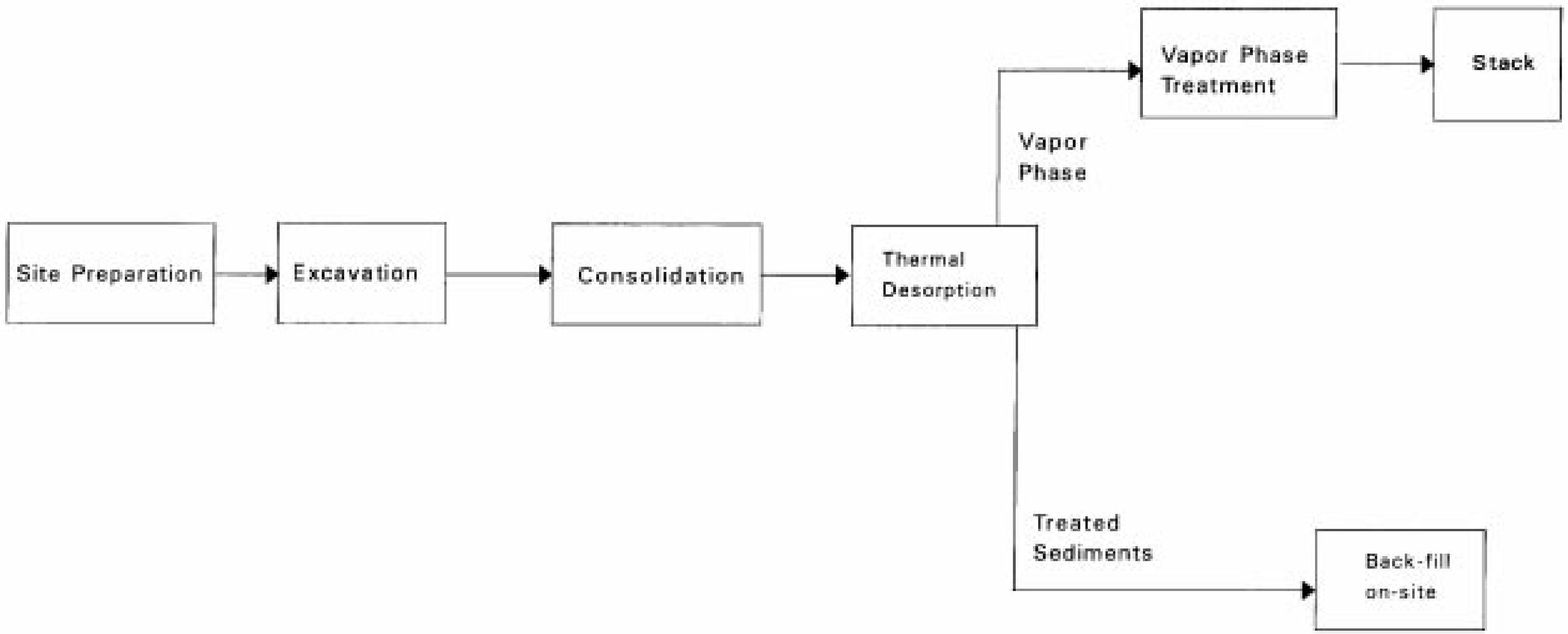
The estimate for this option is based on mobilizing a small thermal desorption unit on-site and treating 19,170 tons of waste. Estimated costs include a trial burn and the sampling and analysis of stack emissions and treated material. Also included is stabilization of 10% of the treated material for metals. As can be seen from the estimated quantities, the volume reduction associated with thermal desorption is assumed to be slightly less than that realized by the incineration option. Two estimates are provided below. The first estimate assumes that an "Indirect-Fired" unit will be required by the state. The second assumes that a "Direct-Fired" unit will be allowed. Due to the nature of the contaminants (heavy tars), it is difficult to estimate the feed rate that will prevent fouling of the kiln. Slower rates than those assumed would result in increased costs. A detailed breakdown of the estimate is provided in Appendix B. A summary of the major cost items for each is given below:

## INDIRECT-FIRED UNIT

| ITEM | | QUANT. | UNIT | UNIT COST | TOTAL COST |
|---|---|---|---|---|---|
| 01 | Excavation of Sediments | | LS | | 3,326,700 |
| 02 | Thermal Desorption | 19,170 | ton | 412.73 | 7,912,100 |
| 03 | Sampling and Analysis | 1 | each | | 540,900 |
| 04 | Stabilization | 1,420 | CY | 326.63 | 463,800 |
| 05 | Place Treated Material in Cell | 12,780 | CY | 2.57 | 32,900 |
| 06 | Imported Topsoil Cover, 2-ft | 8,067 | CY | 35.65 | 287,600 |
| 07 | Site Restoration | 3 | acre | 3489.72 | 10,500 |
| **TOTAL FEASIBILITY ESTIMATE** | | | | | **$12,574,500** |

## DIRECT-FIRED UNIT

| ITEM | | QUANT. | UNIT | UNIT COST | TOTAL COST |
|---|---|---|---|---|---|
| 01 | Excavation of Sediments | | LS | | 3,326,700 |
| 02 | Thermal Desorption | 19,170 | ton | 200.39 | 3,841,500 |
| 03 | Sampling and Analysis | 1 | each | | 605,800 |
| 04 | Stabilization | 1,420 | CY | 364.52 | 517,600 |
| 05 | Place Treated Material in Cell | 12,780 | CY | 2.88 | 36,800 |
| 06 | Imported Topsoil Cover, 2-ft | 8,067 | CY | 39.92 | 322,100 |
| 07 | Site Restoration | 3 | acre | 3908.49 | 11,700 |
| **TOTAL FEASIBILITY ESTIMATE** | | | | | **$ 8,662,200** |




Conceptual Process Flow-chart for Thermal Desorption



FIGURE E-7

## F. COMPARATIVE ANALYSIS OF REMOVAL OPTIONS

This section summarizes and compares the effectiveness of each early action alternative for the Tennessee Products Site.

### 1. SUMMARY OF ALTERNATIVES EVALUATION

In order for a specific alternative to be selected for early action, three main groups of criteria must be met. The threshold criteria (overall protection of human health and the environment and compliance with ARARs) must be satisfied by the early action alternatives being considered. The secondary criteria (long-term effectiveness and permanence, reduction of M/T/V through treatment, short-term effectiveness, implementability, and cost) are used as balancing criteria amoung those alternatives which satisfy the threshold criteria. The modifying criteria, which includes state and community acceptance, will be evaluated by EPA and the state before final selection of an alternative. Each of the six alternatives for the Chattanooga Creek Site were evaluated individually on the basis of the threshold and balancing criteria. A summary of this analysis is presented in Table F-1.

### 2. COMPARATIVE ANALYSIS SUMMARY OF ALTERNATIVES

Table F-2 presents a comparison of each remedial action alternative along with ranking scores for each evaluation criterion. Each alternative's performance against the criteria (except for cost) is ranked on a scale of zero to five, with zero indicating that none of the criteria's requirements are met and five indicating all of the requirements are met. The ranking scores are not intended to be quantitative or additive, rather they are summary indicators only of each alternative's performance against the CERCLA evaluation criteria. The ranking scores combined with the costs provide the basis for comparison among alternatives.

### 3. CONCLUSIONS/RECOMMENDATIONS:

The comparison of alternatives summarizes the relative strengths and weaknesses of each alternative in relation to the evaluation criteria. It also provides a ranking of each of the alternative's performance against each of the criteria. Based upon this analysis, three alternatives stand out in terms of their performance against the criteria. They are On-Site Incineration, On-Site Thermal Desorption, and Off-Site Waste-To-Fuel. Although the two modifying criteria, "State Acceptance" and Community Acceptance" were not evaluated, it is anticipated that the Off-Site Waste-To-Fuel alternative would be favored. This alternative provides the same level of protection as the On-Site Treatment alternatives but in addition eliminates the potential annoyances of on-site treatment and achieves a beneficial re-use of the material. Furthermore, the Off-Site Waste-To-Fuel alternative was estimated to have the lowest cost of these three high ranking alternatives. The reliability of this cost data is estimated to be high due to the recent removal action performed at the site.

Some uncertainty exists whether all sediments, particularly those downstream of Southern Wood Piedmont, will have sufficient BTU value to meet criteria for the Waste-To-Fuel alternative. If a small quantity of sediments fall into this category, blending with more highly contaminated sediments may provide adequate feed for the Waste-To-Fuel alternative. If a large quantity of sediments fall into this category, On-Site Thermal Desorption is the preferred alternative for the non-criteria sediments.

Therefore, it is recommended that the Off-Site Waste-To-Fuel alternative be selected as the preferred alternative with On-Site Thermal Desorption considered as a contingency alternative for sediments not meeting Waste-To-Fuel criteria.

## TABLE F-1
## SUMMARY OF ALTERNATIVES EVALUATED
## TENNESSEE PRODUCTS SITE
## CHATTANOOGA, TENNESSEE

| Remedial Alternative | Overall Protection of Human Health and the Environment | Compliance with ARARs | Long-Term Effectiveness and Permanence | Reduction of M/T/V Through Treatment | Short-Term Effectiveness | Implementability | Total Cost ($) |
|---|---|---|---|---|---|---|---|
| 1 - No Action | Exposure pathways are not eliminated. This alternative is not protective of human health and the environment. | Does not meet Chemical Specific ARARs. | No control for exposure of contaminated sediments. All current and future risk to human health and the environment remain. | There is no treatment to reduce mobility, toxicity, or volume of the contaminated sediment. | No adverse impacts due to construction. Continued exposure to COCs will adversely affect human health and urban biota on the site and any fauna feeding upon them. Baseline Risks to human and ecological receptors is summarized in Section C. | Not a concern since no action will be taken. | $0 |
| 2 - Re-Routing and Containment | Direct dermal contact would be eliminated, but the sediments would remain in place and long-term migration of organics to groundwater is possible. Therefore, this alternative may not be protective of human health and the environment. | This option will not meet Chemical-specific ARARs unless sediments are treated in-situ prior to backfill. A waiver may be required for the prior to implementing this alternative. | Stabilization is not effective for organics. PAHs will still be present in stabilized matrix and the possibility for leaching into groundwater and surround environment remains. Long-term monitoring and five-year reviews would be required. | There is no treatment to reduce toxicity or volume of the contaminated sediments. Mobility will be reduced through stabilization and isolation from the surround environment. Leachability of organics to groundwater is still a potential. | Excavation and solidification may result in the potential release of dust. Level D protective equipment and air monitoring will be required during all activities. Noise nuisances from heavy equipment. Aquatic environment and plant species may be temporarily disturbed and/or eliminated. | Technically implementability is high. Conventional construction equipment can be used and is readily available. Due to nature of area, potential exists to encounter previously unknown contaminated areas. Other areas of concern are the need for extensive real estate acquisition and possible relocation of utilities. | $6,707,900 |
| 3 - Removal and On-Site Landfilling | Exposure pathways eliminated through isolation in an engineered landfill. Human health and the environment will be protected unless some portion of the containment system fails. Five years reviews required. | This option will not meet Chemical-specific ARARs unless sediments are treated prior to be placed in the landfill. A landban waiver may be required for the organics prior to implementing this alternative. | Substantially reduces the risk of exposure unless some component of the landfill fails. Long-term O&M of landfill will be required as will five-year reviews. The uncertainties associated with land disposal of residuals and untreated wastes are high beyond the life of the landfill. | Stabilization prior to landfilling will increase volume. No toxicity reduction. Mobility will be significantly reduced by isolation in an engineered landfill. | Excavation and solidification may result in the potential release of dust. Level D protective equipment and air monitoring will be required during all activities. Noise nuisances from heavy equipment. Aquatic environment and plant species may be temporarily disturbed and/or eliminated. | A land ban waiver must be obtained in order to landfill the contaminated sediments without pretreatment for organics via thermal treatment. Landfill component construction requires expertise which is readily available in that area of the country. | $6,321,600 |
| 4 - Removal and Off-Site Waste-To-Fuel | Eliminates exposure pathways and level of risk. Removes contamination and eliminates further migration. | ARARs will be met through excavation of the contaminated sediments and off-site treatment at a permitted facility. | Long-term human health and environmental risks are eliminated through excavation and off-site treatment. | Maximum reduction of mobility, volume, and toxicity. | Excavation may result in the potential release of dust. Level D protective equipment and air monitoring will be required during all activities. Noise nuisances from heavy equipment. Aquatic environment and plant species may be temporarily disturbed and/or eliminated. | Was successfully implemented during the 1997-98 Early Removal Action. Unknown factors include the level of contamination of sediments downstream of Southern Piedmont and corresponding BTU value. Additional processing of these sediments may be required if BTU value is below 5,000. Material must be accepted by treatment facility. | $7,479,400 |

**TABLE F-1**
**SUMMARY OF ALTERNATIVES EVALUATED**
**TENNESSEE PRODUCTS SITE**
**CHATTANOOGA, TENNESSEE**

| Remedial Alternative | Overall Protection of Human Health and the Environment | Compliance with ARARs | Long-Term Effectiveness and Permanence | Reduction of M/T/V Through Treatment | Short-Term Effectiveness | Implementability | Total Cost ($) |
|---|---|---|---|---|---|---|---|
| 5 - Removal and On-Site Incineration | Eliminates exposure pathways and level of risk. Removes contamination and eliminates further migration. | Chemical-Specific ARARs will be met through destruction of the contaminants in the sediments. The process will be designed to meet Action-Specific ARARs. | Long-term human health and environmental risks are eliminated through excavation and destruction of contaminants. | Maximum reduction of mobility, volume, and toxicity. | Excavation may result in the potential release of dust. Level D protective equipment and air monitoring will be required during all activities. Noise nuisances from heavy equipment and operation of the incinerator. Aquatic environment and plant species may be temporarily disturbed and/or eliminated. | Readily implementable. Unknown factors include the amount of preprocessing required before treatment. Also availability of mobile incineration units may be limited. | $12,151,400 |
| 6 - Removal and On-Site Thermal Desorption | Eliminates exposure pathways and level of risk. Removes contamination and eliminates further migration. | Chemical-Specific ARARs will be met through desorbing contaminants and either destroying them in an afterburner or collecting and disposing of them. The process will be designed to meet Action-Specific ARARs. | Long-term human health and environmental risks are eliminated through excavation and either collection or destruction of contaminants as part of the thermal desorption process. | Maximum reduction of mobility, volume, and toxicity. | Excavation may result in the potential release of dust. Level D protective equipment and air monitoring will be required during all activities. Noise nuisances from heavy equipment and the thermal desorption unit. Aquatic environment and plant species may be temporarily disturbed and/or eliminated. | Readily implementable. Unknown factors include the amount of preprocessing required before treatment and feed rate to prevent fouling of the kiln. If Indirect-Fired units are required, availability of a mobile unit may be limited. Direct fired units should be readily available. | (a) $12,574,500<br>$ 8,662,200 |

(a) The top number represents the cost if an Indirect-Fired Unit is used and the bottom number represents the cost of a Direct-Fired Unit



F-4

## TABLE F-2
## COMPARATIVE ANALYSIS OF ALTERNATIVES
## TENNESSEE PRODUCTS SITE
## CHATTANOOGA, TENNESSEE

| Remedial Alternative | Criteria Rating (a) | | | | | | |
|---|---|---|---|---|---|---|---|
| | Overall Protection of Human Health and the Environment | Compliance with ARARs | Long-Term Effectiveness and Permanence | Reduction of M/T/V Through Treatment | Short-Term Effectiveness | Implement-ability | Total Cost ($) |
| 1 - No Action | 0 | 0 | 0 | 0 | NA | NA | $0 |
| 2 - Re-Routing and Containment | 2 | 1 | 1 | 1 | 4 | 3 | $6,707,900 |
| 3 - Removal and On-Site Landfilling | 3 | 2 | 3 | 2 | 4 | 3 | $6,321,600 |
| 4 - Removal and Off-Site Waste-To-Fuel | 5 | 5 | 5 | 5 | 4 | 4 | $7,479,400 |
| 5 - Removal and On-Site Incineration | 5 | 5 | 5 | 5 | 4 | 4 | $12,151,400 |
| 6 - Removal and On-Site Thermal Desorption | 5 | 5 | 5 | 5 | 4 | 4 | (b)$12,574,400<br>$ 8,662,300 |

(a) A ranking of "0" indicates noncompliance while a ranking of "5" indicates complete compliance

(b) The top number represents the cost if an Indirect-Fired Unit is used and the bottom number represents the cost of a Direct-Fired Unit

# APPENDIX A

## APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS

*Action-specific ARARs for the options were provided to the COE by the USEPA. These are included here as well as some general ARARs from the REOPT database. The COE has not received State ARARs.*

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# ALTERNATIVES RETAINED AND THEIR MAJOR POTENTIAL FEDERAL ARARs FOR THE CHATTANOOGA CREEK PROJECT'S FOCUSED FEASIBILITY STUDY BY THE USACE AND THE USEPA

## I. IN SITU OPTIONS

### PHYSICAL — I.A. Re-Routing and Encapsulation

Description: Re-route Creek channel away from Areas of Contamination (AOCs) by means of excavation and dredging; use clay and/or lime to encapsulate and stabilize coal tar sludges; fill in old Creek channel with material excavated for new channel. Seed, re-plant filled-in old channel area according to wetlands needs.

1. Discharge of Dredge & Fill Material to Waters of the U.S.:
   40 CFR 230 and 33 CFR 320-330

2. Excavation: 40 CFR 268 (Subpart D)

3. Dredging: (1) Closure with No Post-Closure Care: (navigable waters?)
   40 CFR 264.111
   (2) Closure with Waste in Place:
   40 CFR 264.228(a)(2), 264.258(b), 264.310, 264.280

## II.A. EX SITU CONTAINMENT OPTIONS

### PHYSICAL — II.A.1. Temporary On-Site Storage

Description: Dredge/excavate coal tar sludges and contaminated sediments and store temporarily near the Creek or on TPC property in lined impoundments or tanks while awaiting final decisions on treatment and disposal. Dewater and treat resulting liquid before discharge.

1. Container Storage: 40 CFR 264.171-.178, 268.50

2. Construction of a New Surface Impoundment: 40 CFR 264.220-.221

3. Dike Stabilization: 40 CFR 264.221-.227

### PHYSICAL — II.A.2. On-Site Landfill

Description: Excavate/dredge coal tar sludges from the Creek. Construct a secure landfill or vault on the TPC property and place the coal tar sludges in it; sludges may be stabilized. Landfill or vault will be capped and closed. Monitoring will be initiated.

1. Dredging: (1) Closure with No Post-Closure Care (navigable waters?)
   40 CFR 264.111
   (2) Closure with Waste in Place
   40 CFR 264.228(a)(2), 264.258(b), 264.310, 264.280

2. Excavation: 40 CFR 268 (Subpart D)

3. Placement of Liquid Waste in Landfill: 40 CFR 264.314

4. Placement of Waste in Land Disposal Unit: 40 CFR 268 (Subpart D)

5. Capping: (1) Surface Impoundments - 40 CFR 264.228(a)
   (2) Waste Piles - 40 CFR 264.258(b)
   (3) Landfills - 40 CFR 264.310(a)

| PHYSICAL | II.A.3. Off-Site Landfill |
|---|---|

**Description:** Excavate/dredge coal tar sludges from the Creek; sludges may be stabilized or treated in some way. Transport containerized sludges to off-site landfill for disposal.

1. Dredging: 33 U.S.C. 403; 33 CFR 320-330; 40 CFR 264.111 (navigable waters?)

2. Excavation: 40 CFR 268 (Subpart D)

3. Placement of Liquid Waste in Landfill: 40 CFR 264.314

4. Placement of Waste in Land Disposal Unit: 40 CFR 268 (Subpart D)

5. Treatment (in a unit): (1) Tanks - 40 CFR 264.190- 264.192
   (2) Surface Impoundments - 40 CFR 264.221
   (3) Misc. Treatment Units - 40 CFR 264.601

6. Treatment (when Waste will be Land Disposed): (1) 40 CFR 268.10-.12
   (2) 40 CFR 268.41
   (3) 40 CFR 268 (Subpart D)

## II.B. EX SITU TREATMENT OPTIONS

| BIOLOGICAL | II.B.1. Bioslurry |
|---|---|

**Description:** Excavate/dredge coal tar sludges from the Creek. Consolidate sludges. Hold sludges until treatment process is ready. Treat sludges/sediments in bioslurry tank(s) where liquid medium is water. Treatment sludge will be analyzed and, if deemed hazardous, will be further treated and/or (stabilized and) Land Disposed; if deemed nonhazardous, it will be Land Disposed. Liquid will be treated to TNPDES discharge levels and discharged to a POTW line or to the Creek.

1. Treatment (in a unit): (1) Tanks - 40 CFR 264.190-.192
   (2) Miscellaneous Treatment Units - 40 CFR 264.601

2. Treatment (when waste will be Land Disposed): (1) 40 CFR 268.10-.12 & .41
   (2) 40 CFR 268 (Subpart D)

3. Discharge of Treatment System Effluent: (1) BAT/BCT - 40 CFR 122.44(a)
   (2) WQS - 40 CFR 122.44 & State regs under 40 CFR 131 & 40 CFR 122.44(e)
   (3) BMP -40 CFR 125.100 & 40 CFR 125.104
   (4) Monitoring - 40 CFR 122.41(i) & 40 CFR 136.1-136.4

4.

| PHYSICAL | II.B.6. Stabilization |
|---|---|

**Description:** Excavate/dredge coal tar sludges from the Creek. Consolidate the sludges. Stabilize sludges in tank/container/impoundment using lime or Portland cement or a combination of additives. Analyze treated material for leachability of contaminants. Land Dispose treated material.

1. Treatment (in a unit): (1) Tanks - 40 CFR 264.190-.192
   (2) Surface Impoundments - 40 CFR 264.221
   (3) Miscellaneous Treatment Units - 40 CFR 264.601

2. Treatment (when waste will be Land Disposed): 40 CFR 268.10-.12, .41 & Subpart D



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|---|
| 3. Waste Pile: 40 CFR 264.251 & 40 CFR 268.2 |
| 4. Closure with Waste In Place: (1) 40 CFR 264.228(a)(2) (2) 40 CFR 264.258(b) (3) 40 CFR 264.310 |
| 5. Consolidation between Units (consolidate AOC's into one AOC or into one container/tank for processing): Container Storage - 40 CFR 264.171-.178 & 40 CFR 268.50. Construction of a New Surface Impoundment - 40 CFR 264.220-.221. |
| **CHEMICAL** II.B.6. Chemical Reduction |
| Description: Excavate/dredge coal tar sludge from the Creek. Consolidate sludges and dilute. Oxidizable organics treated with commercially available oxidants. Sludge must be slurried before treatment to achieve a suspended solids content of < 3 %. Treatment process generates an effluent that requires further treatment. Resulting slurry must be dewatered and liquid must be treated. ARARs same as in II.B.9. below. |
| **CHEMICAL** II.B.9. Chemical Oxidation |
| Description: Excavate/dredge coal tar sludge from the Creek. Consolidate sludges and dilute. Oxidizable organics treated with commercially available oxidants. Sludge must be slurried before treatment to achieve a suspended solids content of < 3 %. Treatment process generates an effluent that requires further treatment. Resulting slurry must be dewatered and liquid must be treated before discharge. |
| 1. Consolidation Between Units (consolidate AOC's into one AOC or into one container/tank for processing): Container Storage - 40 CFR 264.171-.178 & 40 CFR 268.50. Construction of a New Surface Impoundment - 40 CFR 264.220-.221. |
| 2. Container Storage: 40 CFR 264.171-.175, .176-.178 & 40 CFR 268.50 |
| 3. Dredging: 33 USC 403 & 33 CFR 320-330 |
| 4. Excavation: 40 CFR 268 (Subpart D) |
| **THERMAL** II.B.11. Off-Site Incineration |
| Description: Excavate/dredge coal tar sludge from the Creek. Consolidate sludges. Containerize sludges and analyze. Transport sludges to off-Site incinerator for thermal treatment. |
| 1. Container Storage: 40 CFR 264.171-.175, .176-.178 |
| 2. Consolidation Between Units (consolidate AOC's into one AOC or into one container/tank for processing): Container Storage - 40 CFR 264.171-.178 & 40 CFR 268.50. Construction of a New Surface Impoundment - 40 CFR 264.220-.221. |
| **THERMAL** II.B.12. On-Site Incineration |
| Description: Excavate/dredge coal tar sludge from the Creek. Consolidate sludges. Containerize sludgess, analyze, and hold until incinerator is ready. Sludges may be mixed with solid or liquid to dilute. Incinerate feed material. Analyze treated residue; either stabilize and land dispose or land dispose residue, according to its hazardous characteristics. |

1. Consolidation Between Units (consolidate AOC's into one AOC or into one container/tank for processing): Container Storage - 40 CFR 264.171-.178 & 40 CFR 268.50. Construction of a New Surface Impoundment - 40 CFR 264.220-.221.

2. Container Storage: 40 CFR 264.171-.175, .176-.178

3. Dredging: 33 USC 403 & 33 CFR 320-330

4. Excavation: 40 CFR 268 (Subpart D)

5. Incineration: 40 CFR 264.341,.351,.340 & 40 CFR 264.343,.342,.345

6. PCBs: 40 CFR 761.70

7. Tank Storage (On-Site): 40 CFR 264.190,.193-.198 & 40 CFR 268.50

8. Treatment (in a unit): Thermal Treatment Units - 40 CFR 265.373

9. Incinerators: 40 CFR 264.343-.345

THERMAL

## II.B.13. Thermal Desorption

__Description__: Excavate/dredge coal tar sludges from the Creek. Consolidate sludges. Containerize sludges, analyze, and hold until thermal desorption device is ready. Sludges may be mixed with "clean" soil to dilute. Thermally desorb feed material. Analyze treated residue; either stabilize and land dispose __or__ land dispose residue, according to its hazardous characteristics.

1. Consolidation Between Units (consolidate AOC's into one AOC or into one container/tank for processing): Container Storage - 40 CFR 264.171-.178 & 40 CFR 268.50. Construction of a New Surface Impoundment - 40 CFR 264.220-.221.

2. Container Storage: 40 CFR 264.171-.176

3. Discharge of Treatment System Effluent: 40 CFR 122.44 & state regs under 40 CFR 131; & 40 CFR 125.100 & .104; 40 CFR 122.41(i); 40 CFR 136.1-136.4.

4. Discharge to Publicly Owned Treatment Works (POTW): 40 CFR 403.5 & local POTW requirements & 40 CFR 270.60.

5. Discharge of Dredge and Fill Material to Waters of the U.S.: 40 CFR 230 & 33 CFR 320-330.

6. Dredging: 33 USC 403 & 33 CFR 320-330.

7. Excavation: 40 CFR 268 (Subpart D)

8. Placement of Waste in Land Disposal Unit: 40 CFR 268 (Subpart D)

9. Placement of Liquid Waste in Land Disposal Unit: 40 CFR 268 (Subpart D)

10. Tank Storage (On-Site): 40 CFR 264.190-.198; 40 CFR 268.50

11. Surface Water Control: 40 CFR 264.251(c)(d) - 40 CFR 264.301(c)(d)

12. Treatment (in a unit): (1) Tanks - 40 CFR 264.190 - .192
(2) Misc. Treatment Units - 40 CFR 264.601

13. Treatment (when Waste will be Land Disposed): 40 CFR 268.10-.12 & .41
40 CFR 268 (Subpart D)

14. Waste Pile: 40 CFR 264.251 and 40 CFR 268.2

**NOTE**: Information is from EPA/540/G-89/006 "CERCLA Compliance with Other Laws Manual" (Part I)

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Date: NOV 23 1994

| Constraint | Effect |
|---|---|
| Artifacts | Actions which alter terrain such that significant scientific, prehistorical, historical or archaeological data are threatened must be designed to recover and preserve artifacts, National Historic Preservation Act. |
| Historic Property | Actions on property included in or eligible for the National Register of Historic Places must be designed to preserve historic properties and minimize harm to National Historic Landmarks, National Historic Preservation Act and 36 CFR 800. |
| Critical Habitat | Actions on sites where endangered or threatened species are present must be designed to conserve species, Endangered Species Act of 1973, Fish and Wildlife Coordination Act, and 33 CFR 320-330. |
| Wetlands | Discharge of dredged or fill material into wetlands without permit is prohibited, Clean Water Act, 40 CFR 230, 33 CFR 320-330; action involving construction or management in wetlands must be designed to avoid adverse effects, minimize potential harm, and preserve and enhance wetlands to the extent possible, 40 CFR 6. |
| Wilderness Area | Actions in federally owned wilderness areas must preserve wilderness and leave it unimpaired, Wilderness Act and 50 CFR 35. |
| Wildlife refuge | Actions in areas designated as part of the National Wildlife Refuge System are regulated in 16 USC Section 668. |
| Stream or river | Actions which divert, channel or modify a stream or river and affect fish or wildlife must be designed to protect fish or wildlife, Fish and Wildlife Coordination Act, and 40 CFR 6; actions that have direct adverse effect on scenic rivers must be avoided, Wild and Scenic Rivers Act. |
| Coastal Zone | Activities affecting the coastal zone must be conducted in a manner consistent with approved state management programs, Coastal Zone Management Act; new federal expenditures for activities within the Coastal Barrier Resource System are prohibited, Coastal Barrier Resources Act. |

Date: NOV 23 1994

| Constraint | Effect |
|---|---|
| Navigable waters | Dredging in navigable waters of the U.S. must comply with Section 10 of Rivers and Harbors Act and U.S. Army Corps of Engineers regulations 33 CFR 320-330 and 33 USC 403. Impact of dredging activity on commercial and military navigation is limited. |
| Transportation | Transport of dredge material may trigger regulations for transportation of hazardous wastes, 40 CFR 170-179. |
| Treatment | If a waste can be classified as a RCRA hazardous waste based on parameters defined in 40 CFR 261, management of the waste, including treatment, handling, storage, disposal, etc., is subject to the Resource Conservation and Recovery Act, RCRA, Subtitle C hazardous waste management requirements. |
| Disposal of Treatment Residuals | Disposal of wastewater is governed by the Clean Water Act, CWA. Ambient Water Quality Criteria developed under the CWA are used by authorized state agencies in the development of site-specific permits for the discharge of wastewater to surface water. General pretreatment standards have been promulgated under the CWA to apply to the discharge of wastewater to a Publicly Owned Treatment Works, POTW. The CWA also requires POTWs to develop local limits for discharges of nondomestic wastewater to the POTW. |
| Treatment Facility Standards | Facilities that perform treatment or storage of hazardous wastes must comply with the RCRA hazardous waste general facility requirements under 40 CFR 264. These requirements include waste analysis, recordkeeping, personnel training, security, contingency and emergency plans and procedures, etc. Facilities must comply with standards specific for the type of facility. |
| Federal facilities | Federal facilities conducting major actions determined to have significant impact on the quality of human environment must comply with the National Environmental Policy Act, NEPA, under 40 CFR 6. The Council on Environmental Quality has issued guidance on the environmental review process. |
| Land Disposal Restrictions | LDRs apply to the disposal of RCRA hazardous waste in a land-based disposal facility, such as, but not limited to, a landfill, surface impoundment, waste pile, land applications, or injection well. Restricted wastes must be treated prior to disposal. Specific treatment standards have been promulgated for specific restricted wastes, 40 CFR 268. |

Date: NOV 23 1994

| Constraint | Effect |
|---|---|
| Dredge material | Discharge of dredged or fill material must not violate state water quality standards or any applicable toxic effluent standards, or cause or contribute to significant degradation of water regulations codified by 40 CFR 230 and 33 CFR 320-330. |
| General | If a waste can be classified as a RCRA hazardous waste based on the parameters defined in 40 CFR 261, management of the waste, including handling, storage, disposal, etc., is subject to the Resource Conservation and Recovery Act, RCRA, Subtitle C hazardous waste management requirements. |
| Wastes containing PCBs | may be subject to management and disposal requirements specified under the Toxic Substances Control Act, TSCA. TSCA regulates PCB containing materials, such as insulating liquids, equipment, debris, etc., at specified PCB concentrations levels, 40 CFR 761. |
| Wastes containing radioactive materials | subject to regulation under a variety of federal regulations, DOE orders, and state regulations. EPA regulates radionuclides in drinking water, Safe Drinking Water Act; surface water, Ambient Water Quality Criteria; and air, Clean Air Act. DOE Orders cover worker safety, exposure to the environment, public exposure, waste management, and mixed, hazardous and radioactive, waste management. The Atomic Energy Act sets specific requirements for work place exposure, and defines levels of radioactive wastes. The Department of Transportation regulates shipment of radioactive wastes. |
| Wastewater | Disposal of wastewater is governed by the Clean Water Act, CWA. Ambient Water Quality Criteria developed under the CWA are used by authorized state agencies in the development of site-specific permits for the discharge of wastewater to surface water. General pretreatment standards have been promulgated under the CWA to apply to the discharge of wastewater to a Publicly Owned Treatment Works, POTW. The CWA also requires POTWs to develop local limits for discharges of nondomestic wastewater to the POTW. |
| Restrictions of land-based disposal | Land Disposal Restrictions apply to the disposal of RCRA hazardous waste in a land-based disposal facility, such as, but not limited to, a landfill, surface impoundment, waste pile, land application, or injection well. Restricted wastes must be treated prior to disposal. Specific treatment standards have been promulgated for specific restricted wastes, 40 CFR 268. |
| Sludge | Disposal standards for sludges depend on the disposal method to be used. Land application of sludges or other sludge reuse options require control of toxic constituents to prevent leaching or runoff. Heavy metals and persistent organics are of particular concern for land-based sludge disposal. Case-by-case standards would apply. Solid waste disposal is governed by RCRA Subtitle D, and implemented by authorized state agencies. Sludges containing free liquids may not be placed in landfills. |
| Treatment Residuals | Waste generated from the treatment of hazardous wastes is considered hazardous unless it can be demonstrated that it possesses none of the hazardous characteristics of the original waste, 40 CFR 261. Non-hazardous wastes are governed by the solid waste requirements of RCRA Subtitle D, and appropriate state standards |

Date: DEC 9 1994

| Constraint | Effect |
| --- | --- |
| Local or state prohibitions on transport | Local or state ordinances may prohibit the transport of hazardous and/or radioactive wastes through their jurisdiction. Appropriate local and state ordinances should be consulted before selecting transportation route. |

Date: DEC 9 1994

| Constraint | Effect |
|---|---|
| Transport permits | Transporters of hazardous waste are required to have an EPA hazardous waste transporter ID number, as specified in 40 CFR 263. Many states have permit or registration requirements for transporters of hazardous wastes and materials. Generators of hazardous waste must provide transporters with manifest as required under 40 CFR 262. The transporter's requirements under the manifest system are listed in 40 CFR 263. No hazardous waste may be transported without a manifest. |
| Maximum load | Maximum net highway loads vary from state-to-state but are uniform for interstate system. Per-axle weight limits are described in 23 CFR 658. |
| Containers | Disposal of hazardous wastes in containers is subject to the RCRA requirements specified in 40 CFR 264 Subpart I. Included are requirements for management of containers, inspections, operation and management of containment systems for container storage areas, special requirements for ignitable, reactive or incompatible wastes, and closure. In addition, the general facility standards, along with the groundwater protection requirements in 40 CFR 264 may apply. |

Date: DEC 9 1994

| Constraint | Effect |
| --- | --- |
| Transportation regulations | See 40 CFR Parts 262 and 263 for RCRA pretransportation and transportation requirements, respectively. See 49 CFR Parts 171 and 172 for general hazardous materials regulations and tables. See 49 CFR Part 173 for general shipping and packaging requirements, Part 174 for carriage by rail, Part 175 for carriage by aircraft, Part 176 for carriage by vessel, and Part 177 for carriage by public highway. |
| Radioactive material | See 10 CFR 71 for packaging of radioactive material for transport and for transportation of radioactive material under certain conditions. |

**Date: DEC 9 1994**

| Constraint | Effect |
|---|---|
| Critical habitat | Actions on sites where endangered or threatened species are present must be designed to conserve species, Endangered Species Act of 1973, Fish and Wildlife Coordination Act, and 33 CFR 320-330. |
| Wetlands | Discharge of dredged or fill material into wetlands without permit is prohibited, Clean Water Act, 40 CFR 230, 33 CFR 320-330; action involving construction or management in wetlands must be designed to avoid adverse effects, minimize potential harm, and preserve and enhance wetlands to the extent possible, 40 CFR 6. |
| Wilderness area | Actions in federally owned wilderness areas must preserve wilderness and leave it unimpaired, Wilderness Act and 50 CFR 35. |
| Underground disposal | Placement of non-containerized or bulk liquid RCRA hazardous waste within salt dome formation, underground mine, or cave is prohibited, 40 CFR 264. |
| Artifacts | Actions which alter terrain such that significant scientific, prehistorical, historical or archaeological data are threatened must be designed to recover and preserve artifacts, National Historic Preservation Act. |
| Historic property | Actions on property included in or eligible for the National Register of Historic Places must be designed to preserve historic properties and minimize harm to National Historic Landmarks, National Historic Preservation Act and 36 CFR 800. |
| Geologic fault | New RCRA treatment, storage, or disposal site may not be located within 200 ft of a fault displaced in Holocene time, 40 CFR 264. |
| Floodplain | RCRA hazardous waste treatment, storage, or disposal facility must be designed, constructed, operated, and maintained to avoid washout if located within 100 year floodplain, 40 CFR 264; remedial actions that occur in a floodplain must be designed to avoid adverse effects, minimize potential harm, restore and preserve natural and beneficial values of the floodplain, 40 CFR 6 and Fish and Wildlife Coordination Act. |
| Wildlife refuge | Actions in areas designated as part of the National Wildlife Refuge System are regulated in 16 USC Section 668. |

Date: DEC 9 1994

| Constraint | Effect |
|---|---|
| Filter aids | Final disposal such as landfill or land application, may determine whether filter aids/polymers can be added. For example, the physical or chemical characteristics of the solids may be changed by the filter aid. |
| Treatment | If a waste can be classified as a RCRA hazardous waste based on parameters defined in 40 CFR 261, management of the waste, including treatment, handling, storage, disposal, etc., is subject to the Resource Conservation and Recovery Act, RCRA, Subtitle C hazardous waste management requirements. |
| Wastes containing PCBs | May be subject to management and disposal requirements specified under the Toxic Substances Control Act, TSCA. TSCA regulates PCB-containing materials, such as insulating liquids, equipment, debris, etc., at specified PCB concentration levels, 40 CFR 761. |
| Wastes containing radioactive materials | Subject to regulation under a variety of federal regulations, DOE orders, and state regulations. EPA regulates radionuclides in drinking water, Safe Drinking Water Act; surface water, Ambient Water Quality Criteria; and air, Clean Air Act. DOE Orders cover worker safety, exposure to the environment, public exposure, waste management, and mixed, hazardous and radioactive, waste management. The Atomic Energy Act sets specific requirements for work place exposure, and defines levels of radioactive wastes. The Department of Transportation regulates shipment of radioactive wastes. |
| Emissions generated by waste treatment | May be regulated under the source control emission requirements of the Clean Air Act, CAA. Source control requirements have been promulgated for specific emission sources, such as incinerators. In addition, in geographic areas where ambient air quality does not meet national standards, new emission sources may be subject to the ambient air quality requirements. Typically, ambient requirements include parameters such as particulates, NOx, SOx, ozone, CO, etc. |
| Treatment facility standards | Facilities that perform treatment or storage of hazardous wastes must comply with the RCRA hazardous waste general facility requirements under 40 CFR 264. These requirements include waste analysis, recordkeeping, personnel training, security, contingency and emergency plans and procedures, etc. Facilities must comply with standards specific for the type of facility. |
| Federal facilities | Federal facilities conducting major actions determined to have significant impact on the quality of human environment must comply with the National Environmental Policy Act, NEPA, under 40 CFR 6. The Council on Environmental Quality has issued guidance on the environmental review process. |
| Treatment or disposal of hazardous waste in land treatment units | Subject to RCRA requirements specified in 40 CFR 264 Subpart M. Included are requirements for design and operation, monitoring, recordkeeping, and special requirements for food chain crops, ignitable or reactive wastes, incompatible wastes, and dioxins and furans. In addition, the general facility standards, along with the groundwater protection requirements in 40 CFR 264 may apply. |

**Date: DEC 9 1994**

| Constraint | Effect |
|---|---|
| Wastewater | Disposal of wastewater is governed by the Clean Water Act, CWA. Ambient Water Quality Criteria developed under the CWA are used by authorized state agencies in the development of site-specific permits for the discharge of wastewater to surface water. General pretreatment standards have been promulgated under the CWA to apply to the discharge of wastewater to a Publicly Owned Treatment Works, POTW. The CWA also requires POTWs to develop local limits for discharges of nondomestic wastewater to the POTW. |
| Restrictions of land-based disposal | Land disposal restrictions apply to the disposal of RCRA hazardous waste in a land-based disposal facility, such as, but not limited to, a landfill, surface impoundment, waste pile, land application, or injection well. Restricted wastes must be treated prior to disposal. Specific treatment standards have been promulgated for specific restricted wastes, 40 CFR 268. |
| Sludge | Disposal standards for sludges depend on the disposal method to be used. Land application of sludges or other sludge reuse options require control of toxic constituents to prevent leaching or runoff. Heavy metals and persistent organics are of particular concern for land-based sludge disposal. Case-by-case standards would apply. Solid waste disposal is governed by RCRA Subtitle D, and implemented by authorized state agencies. Sludges containing free liquids may not be placed in landfills. |
| Treatment residuals | Waste generated from the treatment of hazardous wastes is considered hazardous unless it can be demonstrated that it possesses none of the hazardous characteristics of the original waste, 40 CFR 261. Non-hazardous wastes are governed by the solid waste requirements of RCRA Subtitle D, and appropriate state standards |

Date: DEC 9 1994

| Constraint | Effect |
|---|---|
| Geologic fault | New RCRA treatment, storage, or disposal site may not be located within 200 ft of a fault displaced in Holocene time, 40 CFR 264. |
| Floodplain | RCRA hazardous waste treatment, storage, or disposal facility must be designed, constructed, operated, and maintained to avoid washout if located within 100 year floodplain, 40 CFR 264; remedial actions that occur in a floodplain must be designed to avoid adverse effects, minimize potential harm, restore and preserve natural and beneficial values of the floodplain, 40 CFR 6 and Fish and Wildlife Coordination Act. |
| Underground disposal | Placement of non-containerized or bulk liquid RCRA hazardous waste within salt dome formation, underground mine, or cave is prohibited, 40 CFR 264. |
| Artifacts | Actions which alter terrain such that significant scientific, prehistorical, historical or archaeological data are threatened must be designed to recover and preserve artifacts, National Historic Preservation Act. |
| Historic Property | Actions on property included in or eligible for the National Register of Historic Places must be designed to preserve historic properties and minimize harm to National Historic Landmarks, National Historic Preservation Act and 36 CFR 800. |
| Critical Habitat | Actions on sites where endangered or threatened species are present must be designed to conserve species, Endangered Species Act of 1973, Fish and Wildlife Coordination Act, and 33 CFR 320-330. |
| Wetlands | Discharge of dredged or fill material into wetlands without permit is prohibited, Clean Water Act, 40 CFR 230, 33 CFR 320-330; action involving construction or management in wetlands must be designed to avoid adverse effects, minimize potential harm, and preserve and enhance wetlands to the extent possible, 40 CFR 6. |
| Wilderness Area | Actions in federally owned wilderness areas must preserve wilderness and leave it unimpaired, Wilderness Act and 50 CFR 35. |
| Wildlife refuge | Actions in areas designated as part of the National Wildlife Refuge System are regulated in 16 USC Section 668. |
| Stream or river | Actions which divert, channel or modify a stream or river and affect fish or wildlife must be designed to protect fish or wildlife, Fish and Wildlife Coordination Act, and 40 CFR 6; actions that have direct adverse effect on scenic rivers must be avoided, Wild and Scenic Rivers Act. |
| Coastal Zone | Activities affecting the coastal zone must be conducted in a manner consistent with approved state management programs, Coastal Zone Management Act; new federal expenditures for activities within the Coastal Barrier Resource System are prohibited, Coastal Barrier Resources Act. |

**Date: DEC 9 1994**

| Constraint | Effect |
|---|---|
| RCRA permit standards | RCRA permit standards for owners and operators of RCRA landfills are contained in 40 CFR 264, Subpart N |
| RCRA interim standards | Interim standards for RCRA landfills are contained in 40 CFR 265, Subpart, N. These standards apply until a RCRA permit is issued or the landfill is closed |
| Liner requirements | Install two liners or more, a top liner that prevents waste migration into the liner, and a bottom liner that prevents waste migration through the liner ( 40 CFR 264.301) |
| Leachate collection system | Install leachate collection systems above and below the liners (40 CFR 264.301) |
| Storm water control systems | Construct run-on and run-off control systems capable of handling the peak discharge of a 25-year storm (40 CFR 264.301) |
| Particulate dispersal | Control the dispersal of particulates (40 CFR 254.301) |
| Inspection requirements | Inspect liners and covers during and after installation (40 CFR 264.303); Inspect facility weekly and after storms to detect malfunction of control systems or the presence of liquids in the leachate collection and leak detection systems (40 CFR 264.303) |
| Record keeping | Maintain records of the exact location, dimensions, and contents of waste cells (40 CFR 264.304) |
| Long-term maintenance and monitoring | Long-term maintenance and monitoring is required for a minimum of 30 years for hazardous waste landfills (40 CFR 264.117) |
| Closure requirement | Close each cell with a final cover after the last waste has been received (40 CFR 264.310) |
| Liquid waste prohibitions | No bulk or non-containerized liquid hazardous waste or hazardous waste containing free liquids may be disposed of in landfills (40 CFR 264.314); Containers holding free liquids may not be placed in a landfill unless the liquid is mixed with an absorbent or solidified (40 CFR 264.314) |

Date: DEC 9 1994

| Constraint | Effect |
|---|---|
| Geologic fault | New RCRA treatment, storage, or disposal site may not be located within 200 ft of a fault displaced in Holocene time, 40 CFR 264. |
| Floodplain | RCRA hazardous waste treatment, storage, or disposal facility must be designed, constructed, operated, and maintained to avoid washout if located within 100 year floodplain, 40 CFR 264; remedial actions that occur in a floodplain must be designed to avoid adverse effects, minimize potential harm, restore and preserve natural and beneficial values of the floodplain, 40 CFR 6 and Fish and Wildlife Coordination Act. |
| Underground disposal | Placement of non-containerized or bulk liquid RCRA hazardous waste within salt dome formation, underground mine, or cave is prohibited, 40 CFR 264. |
| Artifacts | Actions which alter terrain such that significant scientific, prehistorical, historical or archaeological data are threatened must be designed to recover and preserve artifacts, National Historic Preservation Act. |
| Historic Property | Actions on property included in or eligible for the National Register of Historic Places must be designed to preserve historic properties and minimize harm to National Historic Landmarks, National Historic Preservation Act and 36 CFR 800. |
| Critical Habitat | Actions on sites where endangered or threatened species are present must be designed to conserve species, Endangered Species Act of 1973, Fish and Wildlife Coordination Act, and 33 CFR 320-330. |
| Wetlands | Discharge of dredged or fill material into wetlands without permit is prohibited, Clean Water Act, 40 CFR 230, 33 CFR 320-330; action involving construction or management in wetlands must be designed to avoid adverse effects, minimize potential harm, and preserve and enhance wetlands to the extent possible, 40 CFR 6. |
| Wilderness Area | Actions in federally owned wilderness areas must preserve wilderness and leave it unimpaired, Wilderness Act and 50 CFR 35. |
| Wildlife refuge | Actions in areas designated as part of the National Wildlife Refuge System are regulated in 16 USC Section 668. |
| Stream or river | Actions which divert, channel or modify a stream or river and affect fish or wildlife must be designed to protect fish or wildlife, Fish and Wildlife Coordination Act, and 40 CFR 6; actions that have direct adverse effect on scenic rivers must be avoided, Wild and Scenic Rivers Act. |
| Coastal Zone | Activities affecting the coastal zone must be conducted in a manner consistent with approved state management programs, Coastal Zone Management Act; new federal expenditures for activities within the Coastal Barrier Resource System are prohibited, Coastal Barrier Resources Act. |

Date: DEC 9 1994

| Constraint | Effect |
|---|---|
| Wastes containing radioactive materials | Subject to regulation under a variety of federal regulations, DOE orders, and state regulations. EPA regulates radionuclides in drinking water, Safe Drinking Water Act; surface water, Ambient Water Quality Criteria; and air, Clean Air Act. DOE Orders cover worker safety, exposure to the environment, public exposure, waste management, and mixed, hazardous and radioactive, waste management. The Atomic Energy Act sets specific requirements for work place exposure, and defines levels of radioactive wastes. The Department of Transportation regulates shipment of radioactive wastes. |
| Wastes containing PCBs | May be subject to management and disposal requirements specified under the Toxic Substances Control Act, TSCA. TSCA regulates PCB-containing materials, such as insulating liquids, equipment, debris, etc., at specified PCB concentration levels, 40 CFR 761. |
| Land Disposal | Land Disposal Restrictions apply to the disposal of RCRA hazardous waste in a land-based disposal facility, such as, but not limited to, a landfill, surface impoundment, waste pile, land applications, or injection well. Restricted wastes must be treated prior to disposal. Specific treatment standards have been promulgated for specific restricted wastes, 40 CFR 268. |
| Disposal | If a waste can be classified as a RCRA hazardous waste based on parameters defined in 40 CFR 261, management of the waste, including treatment, handling, storage, disposal, etc., is subject to the Resource Conservation and Recovery Act, RCRA, Subtitle C hazardous waste management requirements. |
| Disposal standards | Disposal standards for sludges depend on the disposal method to be used. Land application of sludges or other sludge reuse options require control of toxic constituents to prevent leaching or runoff. Heavy metals and persistent organics are of particular concern for land-based sludge disposal. Case-by-case standards would apply. Solid waste disposal is governed by RCRA Subtitle D, and implemented by authorized state agencies. Sludges containing free liquids may not be placed in landfills until the liquid has been stabilized. |
| Treatment Facility Standards | Facilities that perform treatment or storage of hazardous wastes must comply with the RCRA hazardous waste general facility requirements under 40 CFR 264. These requirements include waste analysis, recordkeeping, personnel training, security, contingency and emergency plans and procedures, etc. Facilities must comply with standards specific for the type of facility. |
| Federal facilities | Federal facilities conducting major actions determined to have significant impact on the quality of human environment must comply with the National Environmental Policy Act, NEPA, under 40 CFR 6. The Council on Environmental Quality has issued guidance on the environmental review process. |
| Preparedness and prevention | Compliance with Subpart C of 40 CFR 264 and 265 for fully permitted TSDs and interim status TSDs, respectively. |
| Contingency plan and emergency procedures | Compliance with Subpart D of 40 CFR 264 and 265 for fully permitted TSDs and interim status TSDs, respectively. |
| Manifest system | Compliance with Subpart C of 40 CFR 264 and 265 for permitted TSDs and interim status TSDs, respectively. |

| Constraint | Effect |
|---|---|
| Groundwater monitoring | Interim status TSDs must comply with Subpart F of 40 CFR Part 265; permitted TSDs must comply with Subpart F of 40 CFR Part 264. |
| Closure, post-closure | Interim status TSDs must comply with Subpart G of 40 CFR Part 265; permitted TSDs must comply with Subpart G of 40 CFR Part 264. |
| Financial requirements | Interim status TSDs must comply with Subpart H of 40 CFR Part 265; permitted TSDs must comply with Subpart H of 40 CFR Part 264. |
| Disposal method | Refer to specific disposal technology for other regulatory limitations. |

| Constraint | Effect |
|---|---|
| Geologic fault | New RCRA treatment, storage, or disposal site may not be located within 200 ft of a fault displaced in Holocene time, 40 CFR 264. |
| Floodplain | RCRA hazardous waste treatment, storage, or disposal facility must be designed, constructed, operated, and maintained to avoid washout if located within 100 year floodplain, 40 CFR 264; remedial actions that occur in a floodplain must be designed to avoid adverse effects, minimize potential harm, restore and preserve natural and beneficial values of the floodplain, 40 CFR 6 and Fish and Wildlife Coordination Act. |
| Artifacts | Actions which alter terrain such that significant scientific, prehistorical, historical or archaeological data are threatened must be designed to recover and preserve artifacts, National Historic Preservation Act. |
| Historic property | Actions on property included in or eligible for the National Register of Historic Places must be designed to preserve historic properties and minimize harm to National Historic Landmarks, National Historic Preservation Act and 36 CFR 800. |
| Critical habitat | Actions on sites where endangered or threatened species are present must be designed to conserve species, Endangered Species Act of 1973, Fish and Wildlife Coordination Act, and 33 CFR 320-330. |
| Wetlands | Discharge of dredged or fill material into wetlands without permit is prohibited, Clean Water Act, 40 CFR 230, 33 CFR 320-330; action involving construction or management in wetlands must be designed to avoid adverse effects, minimize potential harm, and preserve and enhance wetlands to the extent possible, 40 CFR 6. |
| Wilderness area | Actions in federally owned wilderness areas must preserve wilderness and leave it unimpaired, Wilderness Act and 50 CFR 35. |
| Wildlife refuge | Actions in areas designated as part of the National Wildlife Refuge System are regulated in 16 USC Section 668. |

**Date: NOV 23 1994**

| Constraint | Effect |
|---|---|
| Treatment | If a waste can be classified as a RCRA hazardous waste based on parameters defined in 40 CFR 261, management of the waste, including treatment, handling, storage, disposal, etc., is subject to the Resource Conservation and Recovery Act, RCRA, Subtitle C hazardous waste management requirements. |
| Wastes containing PCBs | May be subject to management and disposal requirements specified under the Toxic Substances Control Act, TSCA. TSCA regulates PCB-containing materials, such as insulating liquids, equipment, debris, etc., at specified PCB concentration levels, 40 CFR 761. |
| Wastes containing radioactive materials | Subject to regulation under a variety of federal regulations, DOE orders, and state regulations. EPA regulates radionuclides in drinking water, Safe Drinking Water Act; surface water, Ambient Water Quality Criteria; and air, Clean Air Act. DOE Orders cover worker safety, exposure to the environment, public exposure, waste management, and mixed, hazardous and radioactive, waste management. The Atomic Energy Act sets specific requirements for work place exposure, and defines levels of radioactive wastes. The Department of Transportation regulates shipment of radioactive wastes. |
| Emissions generated by waste treatment | May be regulated under the source control emission requirements of the Clean Air Act, CAA. Source control requirements have been promulgated for specific emission sources, such as incinerators. In addition, in geographic areas where ambient air quality does not meet national standards, new emission sources may be subject to the ambient air quality requirements. Typically, ambient requirements include parameters such as particulates, NOx, SOx, ozone, CO, etc. |
| Treatment facility standards | Facilities that perform treatment or storage of hazardous wastes must comply with the RCRA hazardous waste general facility requirements under 40 CFR 264. These requirements include waste analysis, recordkeeping, personnel training, security, contingency and emergency plans and procedures, etc. Facilities must comply with standards specific for the type of facility. |
| Federal facilities | Federal facilities conducting major actions determined to have significant impact on the quality of human environment must comply with the National Environmental Policy Act, NEPA, under 40 CFR 6. The Council on Environmental Quality has issued guidance on the environmental review process. |
| Incineration of hazardous waste | Subject to RCRA requirements specified in 40 CFR 264 Subpart O. Included are requirements for waste analysis, principal organic hazardous constituents, POHCs, performance standards, permits, operation, monitoring and inspections, and closure. In addition, the general facility standards, along with the groundwater protection requirements in 40 CFR 264 may apply. |
| PCBs | Incineration of PCBs is subject to requirements specified in 40 CFR 761. |

Date: NOV 23 1994

| Constraint | Effect |
|---|---|
| Wastewater | Disposal of wastewater is governed by the Clean Water Act, CWA. Ambient Water Quality Criteria developed under the CWA are used by authorized state agencies in the development of site-specific permits for the discharge of wastewater to surface water. General pretreatment standards have been promulgated under the CWA to apply to the discharge of wastewater to a Publicly Owned Treatment Works, POTW. The CWA also requires POTWs to develop local limits for discharges of nondomestic wastewater to the POTW. |
| Restrictions of land-based disposal | Land disposal restrictions apply to the disposal of RCRA hazardous waste in a land-based disposal facility, such as, but not limited to, a landfill, surface impoundment, waste pile, land application, or injection well. Restricted wastes must be treated prior to disposal. Specific treatment standards have been promulgated for specific restricted wastes, 40 CFR 268. |
| Sludge | Disposal standards for sludges depend on the disposal method to be used. Land application of sludges or other sludge reuse options require control of toxic constituents to prevent leaching or runoff. Heavy metals and persistent organics are of particular concern for land-based sludge disposal. Case-by-case standards would apply. Solid waste disposal is governed by RCRA Subtitle D, and implemented by authorized state agencies. Sludges containing free liquids may not be placed in landfills. |
| Treatment residuals | Waste generated from the treatment of hazardous wastes is considered hazardous unless it can be demonstrated that it possesses none of the hazardous characteristics of the original waste, 40 CFR 261. Non-hazardous wastes are governed by the solid waste requirements of RCRA Subtitle D, and appropriate state standards |

Date: NOV 23 1994

| Constraint | Effect |
|---|---|
| Geologic fault | New RCRA treatment, storage, or disposal site may not be located within 200 ft of a fault displaced in Holocene time, 40 CFR 264. |
| Floodplain | RCRA hazardous waste treatment, storage, or disposal facility must be designed, constructed, operated, and maintained to avoid washout if located within 100 year floodplain, 40 CFR 264; remedial actions that occur in a floodplain must be designed to avoid adverse effects, minimize potential harm, restore and preserve natural and beneficial values of the floodplain, 40 CFR 6 and Fish and Wildlife Coordination Act. |
| Underground disposal | Placement of non-containerized or bulk liquid RCRA hazardous waste within salt dome formation, underground mine, or cave is prohibited, 40 CFR 264. |
| Artifacts | Actions which alter terrain such that significant scientific, prehistorical, historical or archaeological data are threatened must be designed to recover and preserve artifacts, National Historic Preservation Act. |
| Historic Property | Actions on property included in or eligible for the National Register of Historic Places must be designed to preserve historic properties and minimize harm to National Historic Landmarks, National Historic Preservation Act and 36 CFR 800. |
| Critical Habitat | Actions on sites where endangered or threatened species are present must be designed to conserve species, Endangered Species Act of 1973, Fish and Wildlife Coordination Act, and 33 CFR 320-330. |
| Wetlands | Discharge of dredged or fill material into wetlands without permit is prohibited, Clean Water Act, 40 CFR 230, 33 CFR 320-330; action involving construction or management in wetlands must be designed to avoid adverse effects, minimize potential harm, and preserve and enhance wetlands to the extent possible, 40 CFR 6. |
| Wilderness Area | Actions in federally owned wilderness areas must preserve wilderness and leave it unimpaired, Wilderness Act and 50 CFR 35. |
| Wildlife refuge | Actions in areas designated as part of the National Wildlife Refuge System are regulated in 16 USC Section 668. |

Date: NOV 23 1994

| Constraint | Effect |
|---|---|
| Residual solids | Treated solids can be returned to original site if residual contaminant levels are low. However, backfilling should comply with 40 CFR 268.8, 40 CFR 260 through 264 and CERCLA Section 121, on cleanup standards. |
| Aqueous residuals | Disposal of aqueous residuals must comply with 40 CFR 268.8, National Pollution Discharge Elimination System standards, 40 CFR 125, and pretreatment standards for discharge to publicly owned treatment works, 40 CFR 403. |
| Organic residuals | Disposal of organic residuals must also comply with regulations noted above for solid and aqueous residuals. Organics burnt for fuel value must comply with EPA regulations for management of hazardous waste sites, 40 CFR 266. Polychlorinated biphenyls regulated under Toxic Substances Control Act. |
| Treatment Facility Standards | Facilities that perform treatment or storage of hazardous wastes must comply with the RCRA hazardous waste general facility requirements under 40 CFR 264. These requirements include waste analysis, recordkeeping, personnel training, security, contingency and emergency plans and procedures, etc. Facilities must comply with standards specific for the type of facility. |
| Federal facilities | Federal facilities conducting major actions determined to have significant impact on the quality of human environment must comply with the National Environmental Policy Act, NEPA, under 40 CFR 6. The Council on Environmental Quality has issued guidance on the environmental review process. |

Date: NOV 23 1994

| Constraint | Effect |
|---|---|
| General | If a waste can be classified as a RCRA hazardous waste based on the parameters defined in 40 CFR 261, management of the waste, including handling, storage, disposal, etc., is subject to the Resource Conservation and Recovery Act, RCRA, Subtitle C hazardous waste management requirements. |
| Wastes containing PCBs | may be subject to management and disposal requirements specified under the Toxic Substances Control Act, TSCA. TSCA regulates PCB containing materials, such as insulating liquids, equipment, debris, etc., at specified PCB concentrations levels, 40 CFR 761. |
| Wastes containing radioactive materials | subject to regulation under a variety of federal regulations, DOE orders, and state regulations. EPA regulates radionuclides in drinking water, Safe Drinking Water Act; surface water, Ambient Water Quality Criteria; and air, Clean Air Act. DOE Orders cover worker safety, exposure to the environment, public exposure, waste management, and mixed, hazardous and radioactive, waste management. The Atomic Energy Act sets specific requirements for work place exposure, and defines levels of radioactive wastes. The Department of Transportation regulates shipment of radioactive wastes. |
| Wastewater | Disposal of wastewater is governed by the Clean Water Act, CWA. Ambient Water Quality Criteria developed under the CWA are used by authorized state agencies in the development of site-specific permits for the discharge of wastewater to surface water. General pretreatment standards have been promulgated under the CWA to apply to the discharge of wastewater to a Publicly Owned Treatment Works, POTW. The CWA also requires POTWs to develop local limits for discharges of nondomestic wastewater to the POTW. |
| Restrictions of land-based disposal | Land Disposal Restrictions apply to the disposal of RCRA hazardous waste in a land-based disposal facility, such as, but not limited to, a landfill, surface impoundment, waste pile, land application, or injection well. Restricted wastes must be treated prior to disposal. Specific treatment standards have been promulgated for specific restricted wastes, 40 CFR 268. |
| Treatment Residuals | Waste generated from the treatment of hazardous wastes is considered hazardous unless it can be demonstrated that it possesses none of the hazardous characteristics of the original waste, 40 CFR 261. Non-hazardous wastes are governed by the solid waste requirements of RCRA Subtitle D, and appropriate state standards |
| Emissions | Emissions generated by waste treatment may be regulated under the source control emission requirements of the Clean Air Act, CAA. Source control requirements have been promulgated for specific emission sources, such as incinerators. In addition, in geographic areas where ambient air quality does not meet national standards, new emission sources may be subject to the ambient air quality requirements. Typically, ambient requirements include parameters such as particulates, NOx, SOx, ozone, CO, etc. |

# APPENDIX B

# DETAILED COST ESTIMATES

## DIVERSION/DEWATERING & EXCAVATION

**This is a component of all ex-site alternatives.**

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Feasibility estimate for:
Removal option for" Diversion/De
watering and Excavation", TN
products site, Operable unit 1,
Chattanooga Creek, TN

Designed By: CENWK
Estimated By: CENWK-ED-C

Prepared By: Tom Zimmerman
Price level date: Oct 1999

Preparation Date: 06/02/99
Effective Date of Pricing: 10/01/99
Est Construction Time: 275 Days

Sales Tax: 7.80%

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Site Description:

The Tennessee Products Site is located in Chattanooga, TN on an approximate 2.5 mile stretch of the Chattanooga Creek where coal tar material was dumped in the creek and surrounding areas.

Removal Description:

The update consists of revising the quantity of contaminated material from approximately 25,000 c.y. to 14,200 c.y. The work consists of clearing and grubbing 7 acres medium sized timber to 10" diam for haul road and diversion piping; Installation and removal of 15,000 l.f. of 24' wide 10" rock haul road; Contruction and removal of 5 cofferdams (Sheetpiling), 6,250 s.f.; Diversion of creek using four 16" lift pumps and 9,000' of diversion piping; Dewatering of creek segments; Excavation of 14,200 c.y. coal tar sediments/soil; Hauling removed material to products site; Preprocessing material in prepartion for off-site disposal to an Energy recycling plant; Seeding and Mulching and grading cleared areas and disturbed areas; Associated General Conditions, Temporary Facilities and Health and Safety for a 9 month construction period.

10% G&A, 8% profit, 9.9% escalation.

No construction or design contingency was applied as this was considered in calculation of quantities.

2% engineering and design applied. 23% budgetary cost factor applied, of which 15% is bid contingency, 6% is construction management and 2% is engineering during construction and Lab QA.

Subsequent to preparation of this feasibility estimate in 1995, a removal action was completed in Dec 1998 at this site for a segment of the river. Approximately 25,000 c.y. were removed and disposed of off-site. These actual costs were considered in preparation of this revised feasibility estimate.

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SUMMARY REPORTS SUMMARY PAGE



DETAILED ESTIMATE DETAIL PAGE



No Backup Reports...

* * * END TABLE OF CONTENTS * * *

** PROJECT OWNER SUMMARY - Bid Item (Rounded to 100's) **

| | | QUANTITY | UOM | CONTRACT | ESCALATN | E&D | BUDGET | TOTAL COST | UNIT COST |
|---|---|---|---|---|---|---|---|---|---|
| 01 | General Conditions | 9.00 | MO | 588,500 | 58,300 | 12,900 | 151,700 | 811,500 | 90163.50 |
| 02 | Temporary Facilities | 9.00 | MO | 104,500 | 10,300 | 2,300 | 26,900 | 144,100 | 16010.97 |
| 03 | Health and Safety | 9.00 | MO | 211,100 | 20,900 | 4,600 | 54,400 | 291,000 | 32337.43 |
| 04 | Clearing and Grubbing | 7.00 | ACR | 32,100 | 3,200 | 700 | 8,300 | 44,300 | 6330.34 |
| 05 | Install & Remove Haul Road | 9400.00 | LF | 288,000 | 28,500 | 6,300 | 74,300 | 397,100 | 42.25 |
| 06 | Sheetpile (cofferdam) | 6250.00 | SF | 196,300 | 19,400 | 4,300 | 50,600 | 270,600 | 43.30 |
| 07 | Creek Diversion | 8500.00 | LF | 745,500 | 73,800 | 16,400 | 192,200 | 1,027,900 | 120.93 |
| 08 | Channel Excavation | 14200.00 | CY | 118,300 | 11,700 | 2,600 | 30,500 | 163,100 | 11.49 |
| 09 | Haul Material to Site | 14200.00 | CY | 20,000 | 2,000 | 400 | 5,100 | 27,500 | 1.94 |
| 10 | Material Preprocessing | 14200.00 | CY | 94,600 | 9,400 | 2,100 | 24,400 | 130,400 | 9.19 |
| 11 | Site Restoration | 8.00 | ACR | 13,700 | 1,400 | 300 | 3,500 | 19,000 | 2369.74 |
| TOTAL | Feasibility estimate for: | 1.00 | EA | 2,412,700 | 238,900 | 53,000 | 622,100 | 3,326,700 | 3326657 |

** PROJECT INDIRECT SUMMARY - Bid Item (Rounded to 100's) **

| | | QUANTITY | UOM | DIRECT | G&A | PROFIT | BOND | TOTAL COST | UNIT COST |
|---|---|---|---|---|---|---|---|---|---|
| 01 | General Conditions | 9.00 | MO | 490,500 | 49,000 | 43,200 | 5,800 | 588,500 | 65392.48 |
| 02 | Temporary Facilities | 9.00 | MO | 87,100 | 8,700 | 7,700 | 1,000 | 104,500 | 11612.20 |
| 03 | Health and Safety | 9.00 | MO | 175,900 | 17,600 | 15,500 | 2,100 | 211,100 | 23453.22 |
| 04 | Clearing and Grubbing | 7.00 | ACR | 26,800 | 2,700 | 2,400 | 300 | 32,100 | 4591.18 |
| 05 | Install & Remove Haul Road | 9400.00 | LF | 240,000 | 24,000 | 21,100 | 2,900 | 288,000 | 30.64 |
| 06 | Sheetpile (cofferdam) | 6250.00 | SF | 163,600 | 16,400 | 14,400 | 1,900 | 196,300 | 31.40 |
| 07 | Creek Diversion | 8500.00 | LF | 621,300 | 62,100 | 54,700 | 7,400 | 745,500 | 87.71 |
| 08 | Channel Excavation | 14200.00 | CY | 98,600 | 9,900 | 8,700 | 1,200 | 118,300 | 8.33 |
| 09 | Haul Material to Site | 14200.00 | CY | 16,600 | 1,700 | 1,500 | 200 | 20,000 | 1.41 |
| 10 | Material Preprocessing | 14200.00 | CY | 78,800 | 7,900 | 6,900 | 900 | 94,600 | 6.66 |
| 11 | Site Restoration | 8.00 | ACR | 11,500 | 1,100 | 1,000 | 100 | 13,700 | 1718.69 |
| TOTAL | Feasibility estimate for: | 1.00 | EA | 2,010,800 | 201,100 | 176,900 | 23,900 | 2,412,700 | 2412710 |

| | |
|---|---|
| ESCALATION | 238,900 |
| SUBTOTAL | 2,651,600 |
| E&D 2% | 53,000 |
| SUBTOTAL | 2,704,600 |
| BUDGET 23% | 622,100 |
| TOTAL INCL OWNER COSTS | 3,326,700 |

** PROJECT DIRECT SUMMARY - Bid Item (Rounded to 100's) **

| | | QUANTITY | UOM | MANHOUR | LABOR | EQUIPMNT | MATERIAL | QUOTE | TOTAL COST | UNIT COST |
|---|---|---|---|---|---|---|---|---|---|---|
| 01 | General Conditions | 9.00 | MO | 7,200 | 308,900 | 15,800 | 5,400 | 160,400 | 490,500 | 54499.18 |
| 02 | Temporary Facilities | 9.00 | MO | 1,100 | 17,800 | 2,900 | 59,100 | 7,300 | 87,100 | 9677.80 |
| 03 | Health and Safety | 9.00 | MO | 1,900 | 61,700 | 20,800 | 93,400 | 0 | 175,900 | 19546.31 |
| 04 | Clearing and Grubbing | 7.00 | ACR | 700 | 11,900 | 14,900 | 0 | 0 | 26,800 | 3826.37 |
| 05 | Install & Remove Haul Road | 9400.00 | LF | 2,400 | 59,200 | 61,500 | 25,800 | 93,600 | 240,000 | 25.53 |
| 06 | Sheetpile (cofferdam) | 6250.00 | SF | 1,200 | 28,600 | 29,700 | 105,300 | 0 | 163,600 | 26.17 |
| 07 | Creek Diversion | 8500.00 | LF | 6,400 | 117,600 | 334,000 | 169,800 | 0 | 621,300 | 73.10 |
| 08 | Channel Excavation | 14200.00 | CY | 1,400 | 29,100 | 48,300 | 21,200 | 0 | 98,600 | 6.94 |
| 09 | Haul Material to Site | 14200.00 | CY | 300 | 6,100 | 10,600 | 0 | 0 | 16,600 | 1.17 |
| 10 | Material Preprocessing | 14200.00 | CY | 1,400 | 28,900 | 50,000 | 0 | 0 | 78,800 | 5.55 |
| 11 | Site Restoration | 8.00 | ACR | 200 | 3,900 | 3,600 | 3,900 | 0 | 11,500 | 1432.39 |
| TOTAL | Feasibility estimate for: | 1.00 | EA | 24,200 | 673,600 | 592,000 | 483,900 | 261,300 | 2,010,800 | 2010792 |

| | |
|---|---|
| GENERAL & ADMINISTRATIVE OVERHEAD 10% | 201,100 |
| SUBTOTAL | 2,211,900 |
| PROFIT (8%) | 176,900 |
| SUBTOTAL | 2,388,800 |
| BOND (1%) | 23,900 |
| TOTAL INCL INDIRECTS | 2,412,700 |
| ESCALATION | 238,900 |
| SUBTOTAL | 2,651,600 |
| E&D 2% | 53,000 |
| SUBTOTAL | 2,704,600 |
| BUDGET 23% | 622,100 |
| TOTAL INCL OWNER COSTS | 3,326,700 |

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R2024: 02330105 WATER TANK,S Equip W30SO006 not recognized -- Not repriced

* * * END OF ERROR REPORT * * *

Project Distributed Costs

| General conditions | QUANTY | UOM | CREW ID | MANHOUR | LABOR | EQUIPMNT | MATERIAL | QUOTE | TOTAL COST |
|---|---|---|---|---|---|---|---|---|---|

General conditions

The Overhead column of 10% is taken as a percentage of the direct costs
and consists G&A.

| HTRW REMEDIAL ACTION | QUANTY UOM | CREW ID | MANHOUR | LABOR | EQUIPMNT | MATERIAL | QUOTE | TOTAL COST |
|---|---|---|---|---|---|---|---|---|
| General Conditions | | | | | | | | |
| HTRW REMEDIAL ACTION | | | | | | | | |
| MOBILIZE AND PREPARATORY WORK | | | | | | | | |
| MOBILIZATION OF PERSONNEL | | | | | | | | |
| Personnel mobilization | | | 0.00 | 160.00 | 0.00 | 0.00 | 0.00 | 160.00 |
| assume crew of 15 x 4 hours x $40/hr= $2,400 | 15.00 EA | | 0 | 2,400 | 0 | 0 | 0 | 2,400 |
| TOTAL MOBILIZATION OF PERSONNEL | | | 0 | 2,400 | 0 | 0 | 0 | 2,400 |
| PREWORK SUBMITTALS | | | | | | | | |
| Prepare plans | | | 0.00 | 1500.00 | 0.00 | 323.40 | 0.00 | 1823.40 |
| 12 plans based on 30 hours x $50/hour= $1,500<br><br>$300/plan costed under material is for paper, binders, mailing, and reproduction. | 12.00 EA | | 0 | 18,000 | 0 | 3,881 | 0 | 21,881 |
| Pre-construction submittals | | | 0.00 | 3000.00 | 0.00 | 323.40 | 0.00 | 3323.40 |
| Health and Safety and Sampling and analysis plans more extensive based on 60 hours x $50/hour= $3,000<br><br>$300/plan costed under material is for paper, binders, mailing, and reproduction. | 2.00 EA | | 0 | 6,000 | 0 | 647 | 0 | 6,647 |
| TOTAL PREWORK SUBMITTALS | | | 0 | 24,000 | 0 | 4,528 | 0 | 28,528 |
| OTHER | | | | | | | | |
| Surveying | | | 0.00 | 0.00 | 0.00 | 0.00 | 1000.00 | 1000.00 |
| | 20.00 DAY | | 0 | 0 | 0 | 0 | 20,000 | 20,000 |
| 3-1/2" x 5", Color, 24 Count | | | 0.00 | 0.00 | 0.00 | 15.42 | 0.00 | 15.42 |
| includes Film | 9.00 EA | N/A | 0 | 0 | 0 | 139 | 0 | 139 |
| Video recorder rental | | | 0.00 | 0.00 | 0.00 | 53.90 | 0.00 | 53.90 |
| Video existing conditions before project begins. Labor covered in field supervision. | 1.00 DAY | | 0 | 0 | 0 | 54 | 0 | 54 |

01. General Conditions

| HTRW REMEDIAL ACTION | QUANTY | UOM | CREW ID | MANHOUR | LABOR | EQUIPMNT | MATERIAL | QUOTE | TOTAL COST |
|---|---|---|---|---|---|---|---|---|---|
| 35 mm Slides, Ectachrome, 24 Ct. | | | | 0.00 | 0.00 | 0.00 | 10.66 | 0.00 | 10.66 |
| Includes Film | 6.00 | EA | N/A | 0 | 0 | 0 | 64 | 0 | 64 |
| Aerial Photo, 11 X 14 Color, By | | | | 0.00 | 0.00 | 0.00 | 269.50 | 0.00 | 269.50 |
| Helicopter | 1.00 | EA | N/A | 0 | 0 | 0 | 270 | 0 | 270 |
| TOTAL OTHER | | | | 0 | 0 | 0 | 526 | 20,000 | 20,526 |
| SUPERVISION/MANAGEMENT | | | | | | | | | |
| TRK,HWY,4X2,F250,3/4T,8600 GVW | | | | 0.00 | 0.00 | 7.31 | 0.00 | 0.00 | 7.31 |
| 4X2 3/4-TON PICK-UP, 8600 GVW, | 2160.00 | HR | T50FO003 | 0 | 0 | 15,792 | 0 | 0 | 15,792 |
| (3 ea) 1/2 time | | | | | | | | | |
| Field Clerk | | | | 1.00 | 20.94 | 0.00 | 0.00 | 0.00 | 20.94 |
| | 1440.00 | HR | X-CLERK | 1,440 | 30,147 | 0 | 0 | 0 | 30,147 |
| General Project Superintendent | | | | 1.00 | 44.63 | 0.00 | 0.00 | 0.00 | 44.63 |
| 9 hours/day for 9 months. | 1760.00 | HR | X-PRJSUPR | 1,760 | 78,543 | 0 | 0 | 0 | 78,543 |
| Project Engineer | | | | 1.00 | 34.46 | 0.00 | 0.00 | 0.00 | 34.46 |
| | 1760.00 | HR | X-PROJENGI | 1,760 | 60,642 | 0 | 0 | 0 | 60,642 |
| Quality Control Manager | | | | 1.00 | 50.33 | 0.00 | 0.00 | 0.00 | 50.33 |
| | 1760.00 | HR | X-QCMANAGR | 1,760 | 88,584 | 0 | 0 | 0 | 88,584 |
| Per Diem | | | | 0.00 | 0.00 | 0.00 | 0.00 | 80.00 | 80.00 |
| for 4 men 252 days= 1008days | 720.00 | DAY | | 0 | 0 | 0 | 0 | 57,600 | 57,600 |
| Program Manager | | | | 1.00 | 46.13 | 0.00 | 0.00 | 0.00 | 46.13 |
| | 120.00 | HR | X-PRGMMGR | 120 | 5,535 | 0 | 0 | 0 | 5,535 |
| Contract Administrator | | | | 1.00 | 38.38 | 0.00 | 0.00 | 0.00 | 38.38 |
| | 120.00 | HR | X-PRJCOADM | 120 | 4,606 | 0 | 0 | 0 | 4,606 |
| Project Engineer | | | | 1.00 | 34.46 | 0.00 | 0.00 | 0.00 | 34.46 |
| | 120.00 | HR | X-PROJENGI | 120 | 4,135 | 0 | 0 | 0 | 4,135 |
| Secretary | | | | 1.00 | 24.15 | 0.00 | 0.00 | 0.00 | 24.15 |
| | 80.00 | HR | X-SECRETRY | 80 | 1,932 | 0 | 0 | 0 | 1,932 |
| Air fare | | | | 0.00 | 0.00 | 0.00 | 0.00 | 500.00 | 500.00 |
| for 4 men go home every 4 weeks | 36.00 | TRP | | 0 | 0 | 0 | 0 | 18,000 | 18,000 |
| 9 trips x 4 men= 36 trips | | | | | | | | | |
| Security | | | | 0.00 | 0.00 | 0.00 | 0.00 | 10.00 | 10.00 |
| 9 months x 30 days/month x 24 | 6480.00 | HR | | 0 | 0 | 0 | 0 | 64,800 | 64,800 |
| hours/day= 6,480 hours. | | | | | | | | | |

| HTRW REMEDIAL ACTION | QUANTY UOM CREW ID | MANHOUR | LABOR | EQUIPMNT | MATERIAL | QUOTE | TOTAL COST |
|---|---|---|---|---|---|---|---|
| TOTAL SUPERVISION/MANAGEMENT | | 7,160 | 274,124 | 15,792 | 0 | 140,400 | 430,316 |
| TOTAL MOBILIZE AND PREPARATORY WORK | | 7,160 | 300,524 | 15,792 | 5,054 | 160,400 | 481,769 |
| DEMOBILIZATION | | | | | | | |
| DEMOB OF CONSTRUCTION EQUIP/FACL | | | | | | | |
| Equipment demobilization | | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| By lowboy: assume 7 trips at | 1.00 EA | 0 | 0 | 0 | 0 | 0 | 0 |
| $500/trip= $3,500. | | | | | | | |
| Under own power: 3 pick-ups; 2 dumps; 1 flatbed. 6 trips at $100/trip= $600. | | | | | | | |
| Trailers: 4 ea at $300/ea= $1,200 | | | | | | | |
| Total: $5,300 | | | | | | | |
| TOTAL DEMOB OF CONSTRUCTION EQUIP/FACL | | 0 | 0 | 0 | 0 | 0 | 0 |
| DEMOB OF PERSONNEL | | | | | | | |
| Personnel demobilization | | 0.00 | 160.00 | 0.00 | 0.00 | 0.00 | 160.00 |
| assume crew of 15 x 4 hours | 15.00 EA | 0 | 2,400 | 0 | 0 | 0 | 2,400 |
| x $40/hr= $2,400 | | | | | | | |
| TOTAL DEMOB OF PERSONNEL | | 0 | 2,400 | 0 | 0 | 0 | 2,400 |
| POST-CONSTRUCTION SUBMITTALS | | | | | | | |
| Close-out report | | 0.00 | 6000.00 | 0.00 | 323.40 | 0.00 | 6323.40 |
| 120 hours x $50/hour= $6,000 | 1.00 EA | 0 | 6,000 | 0 | 323 | 0 | 6,323 |
| $300 costed under material for paper, binders, mailing, and reproduction. | | | | | | | |
| TOTAL POST-CONSTRUCTION SUBMITTALS | | 0 | 6,000 | 0 | 323 | 0 | 6,323 |

| HTRW REMEDIAL ACTION | QUANTY UOM CREW ID | MANHOUR | LABOR | EQUIPMNT | MATERIAL | QUOTE | TOTAL COST |
|---|---|---|---|---|---|---|---|
| CLEAN-UP | | | | | | | |
| Clean-up | | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| assume crew of 15 x 24 hours x $40/hr= $14,400. | 1.00 EA | 0 | 0 | 0 | 0 | 0 | 0 |
| TOTAL CLEAN-UP | | 0 | 0 | 0 | 0 | 0 | 0 |
| TOTAL DEMOBILIZATION | | 0 | 8,400 | 0 | 323 | 0 | 8,723 |
| TOTAL HTRW REMEDIAL ACTION | | 7,160 | 308,924 | 15,792 | 5,377 | 160,400 | 490,493 |
| TOTAL General Conditions | | 7,160 | 308,924 | 15,792 | 5,377 | 160,400 | 490,493 |

| HTRW Remedial Action | QUANTY | UOM | CREW ID | MANHOUR | LABOR | EQUIPMNT | MATERIAL | QUOTE | TOTAL COST |
|---|---|---|---|---|---|---|---|---|---|
| Temporary Facilities | | | | | | | | | |
| HTRW Remedial Action | | | | | | | | | |
| MOBILIZE & PREPARATORY WORK | | | | | | | | | |
| CONSTRUCT TEMPORARY UTILITIES | | | | | | | | | |
| Remove electrical | | | | 1.00 | 27.08 | 0.00 | 0.00 | 0.00 | 27.08 |
| | 40.00 | HR | B-ELECTRN | 40 | 1,083 | 0 | 0 | 0 | 1,083 |
| WATER TANK,SKID,12000GAL,10"PIPE | | | | 0.00 | 0.00 | 3.89 | 0.00 | 0.00 | 3.89 |
| REF. EP 1110-1-8 | 6.00 | MON | W30SO006 | 0 | 0 | 23 | 0 | 0 | 23 |
| 12000 GAL. STAND-TOWER TANK,10"P IPE | | | | | | | | | |
| Al Rdwy Pole,2-12'Truss Arm,30'H | | | | 8.33 | 210.87 | 57.91 | 1530.05 | 0.00 | 1798.83 |
| (9.1M) The hook-up cost is | 1.00 | EA | EELEJ | 8 | 211 | 58 | 1,530 | 0 | 1,799 |
| include in previous item "Install and Remove Electrical" | | | | | | | | | |
| Ext Rdwy 400W HPS Fxtr,E&G,402C | | | | 3.41 | 85.64 | 17.05 | 223.62 | 0.00 | 326.31 |
| | 4.00 | EA | EELEK | 14 | 343 | 68 | 894 | 0 | 1,305 |
| TOTAL CONSTRUCT TEMPORARY UTILITIES | | | | 62 | 1,637 | 149 | 2,425 | 0 | 4,211 |
| SETUP/CONSTR TEMP FACILITIES | | | | | | | | | |
| Trailers | | | | | | | | | |
| Temp Office Trailer 50'X 12 3 ea | | | | 0.00 | 0.00 | 0.00 | 470.85 | 0.00 | 470.85 |
| w/o Hookup | 27.00 | MO | N/A | 0 | 0 | 0 | 12,713 | 0 | 12,713 |
| Temp Const Stor. Van 28 X 10 2ea | | | | 0.00 | 0.00 | 0.00 | 110.79 | 0.00 | 110.79 |
| | 18.00 | MO | N/A | 0 | 0 | 0 | 1,994 | 0 | 1,994 |
| Personal Computer System | | | | 0.00 | 0.00 | 0.00 | 3234.00 | 0.00 | 3234.00 |
| Including Color Monitor, 40MB | 2.00 | EA | N/A | 0 | 0 | 0 | 6,468 | 0 | 6,468 |
| Hard Drive, IBM-DOS Compatable | | | | | | | | | |
| Furniture rental (3 trailers) | | | | 0.00 | 0.00 | 0.00 | 377.30 | 0.00 | 377.30 |
| cabinets, chairs, tables, waste | 27.00 | MO | | 0 | 0 | 0 | 10,187 | 0 | 10,187 |
| baskets | | | | | | | | | |
| Fax machine | | | | 0.00 | 0.00 | 0.00 | 215.60 | 0.00 | 215.60 |
| purchase | 2.00 | EA | N/A | 0 | 0 | 0 | 431 | 0 | 431 |
| Telephones | | | | 0.00 | 0.00 | 0.00 | 53.90 | 0.00 | 53.90 |
| purchase | 4.00 | EA | N/A | 0 | 0 | 0 | 216 | 0 | 216 |

| HTRW Remedial Action | QUANTY | UOM | CREW ID | MANHOUR | LABOR | EQUIPMNT | MATERIAL | QUOTE | TOTAL COST |
|---|---|---|---|---|---|---|---|---|---|
| TOTAL Trailers | | | | 0 | 0 | 0 | 32,009 | 0 | 32,009 |
| Decontamination items | | | | | | | | | |
| Chemicals & Detergents | | | | 0.00 | 0.00 | 0.00 | 86.24 | 0.00 | 86.24 |
| | 1.00 | LS | | 0 | 0 | 0 | 86 | 0 | 86 |
| PRESS WASHR,5.4GPM,PORT,3000 PSI | | | | 0.00 | 0.00 | 2.33 | 0.00 | 0.00 | 2.33 |
| REF. EP 1110-1-8 | 780.00 | HR | W25HO002 | 0 | 0 | 1,817 | 0 | 0 | 1,817 |
| PRESSURE WASHER, 5.4 GPM, 3,000 PSI | | | | | | | | | |
| Assume operates 50% of the time 1560 hours x 50%= 780 hours | | | | | | | | | |
| PUMP,TRASH, 2"D, 10,400GPH/25'HD | | | | 0.00 | 0.00 | 0.84 | 0.00 | 0.00 | 0.84 |
| REF. EP 1110-1-8 | 780.00 | HR | P50HO002 | 0 | 0 | 658 | 0 | 0 | 658 |
| 2" - 10,400 GPH AT 25' HEAD, TRA SH | | | | | | | | | |
| 630 Gallon, Polyethylene, | | | | 0.00 | 0.00 | 0.00 | 323.40 | 0.00 | 323.40 |
| DOT Approved, Monthly Rental | 18.00 | MO | N/A | 0 | 0 | 0 | 5,821 | 0 | 5,821 |
| 2 each, one for supply and one for decon water for 9 months each | | | | | | | | | |
| Stl Post,10'OC demarcation fence | | | | 0.05 | 1.97 | 0.03 | 1.07 | 0.00 | 3.06 |
| | 800.00 | LF | XLABC | 43 | 1,575 | 20 | 853 | 0 | 2,448 |
| Dump Truck Transportation | | | | 0.00 | 0.00 | 0.00 | 592.90 | 0.00 | 592.90 |
| Hazwaste Min Charge | 1.00 | EA | N/A | 0 | 0 | 0 | 593 | 0 | 593 |
| For used PPE | | | | | | | | | |
| Roll-off rental | | | | 0.00 | 0.00 | 0.00 | 10.78 | 0.00 | 10.78 |
| Roll-off used for PPE and disposal of decon pad. | 180.00 | DAY | | 0 | 0 | 0 | 1,940 | 0 | 1,940 |
| Disposal fee | | | | 0.00 | 0.00 | 0.00 | 0.00 | 150.00 | 150.00 |
| PPE and decon pad assumed hazardous, priced as minor item. | 10.00 | TON | | 0 | 0 | 0 | 0 | 1,500 | 1,500 |
| Roll-off mobilization | | | | 0.00 | 0.00 | 0.00 | 377.30 | 0.00 | 377.30 |
| required for disposal of PPE and decon pad. | 4.00 | EA | | 0 | 0 | 0 | 1,509 | 0 | 1,509 |

| HTRW Remedial Action | QUANTY UOM | CREW ID | MANHOUR | LABOR | EQUIPMNT | MATERIAL | QUOTE | TOTAL COST |
|---|---|---|---|---|---|---|---|---|
| Emergency Body Shower And Eye | | | 5.00 | 123.53 | 2.14 | 592.49 | 0.00 | 718.15 |
| Wash Stations | 1.00 EA | MPLUA | 5 | 124 | 2 | 592 | 0 | 718 |
| Assumes Std Hook-Up. No Addition | | | | | | | | |
| al Copper Piping Etc. | | | | | | | | |
| 8' x 36', 2 Showers, 2 Wall | | | 0.00 | 0.00 | 0.00 | 539.00 | 0.00 | 539.00 |
| Fans (Monthly Rental) | 9.00 MO | N/A | 0 | 0 | 0 | 4,851 | 0 | 4,851 |
| 30 Ingredients | | | 0.00 | 0.00 | 0.00 | 64.84 | 0.00 | 64.84 |
| | 1.00 EA | N/A | 0 | 0 | 0 | 65 | 0 | 65 |
| Disposal fee for decon water | | | 0.00 | 0.00 | 0.00 | 0.00 | 0.29 | 0.29 |
| | 20000 GAL | | 0 | 0 | 0 | 0 | 5,800 | 5,800 |
| TOTAL Decontamination items | | | 48 | 1,699 | 2,497 | 16,311 | 7,300 | 27,807 |
| Other temporary facility items | | | | | | | | |
| Toilet Portable Chemical (2 ea) | | | 0.00 | 0.00 | 0.00 | 107.80 | 0.00 | 107.80 |
| | 18.00 MO | N/A | 0 | 0 | 0 | 1,940 | 0 | 1,940 |
| Project Signs, 11 SF to 20 SF | | | 4.00 | 64.01 | 47.99 | 431.20 | 0.00 | 543.20 |
| | 2.00 EA | ULABN | 8 | 128 | 96 | 862 | 0 | 1,086 |
| TOTAL Other temporary facility items | | | 8 | 128 | 96 | 2,803 | 0 | 3,027 |
| TOTAL SETUP/CONSTR TEMP FACILITIES | | | 56 | 1,827 | 2,593 | 51,123 | 7,300 | 62,843 |
| TOTAL MOBILIZE & PREPARATORY WORK | | | 118 | 3,463 | 2,743 | 53,547 | 7,300 | 67,054 |
| SURFACE WATER COLLECT& CONTROL | | | | | | | | |
| EROSION CONTROL | | | | | | | | |
| SEDIMENT BARRIERS | | | | | | | | |
| Silt Fences, Vinyl, 3' High | | | 0.05 | 0.76 | 0.01 | 0.30 | 0.00 | 1.07 |
| With 7.5' Posts | 18800 LF | ULABB | 1,002 | 14,316 | 169 | 5,561 | 0 | 20,047 |
| 9,400 lf of creek x 2 | | | | | | | | |
| sides= 18800 lf. | | | | | | | | |
| TOTAL SEDIMENT BARRIERS | | | 1,002 | 14,316 | 169 | 5,561 | 0 | 20,047 |
| TOTAL EROSION CONTROL | | | 1,002 | 14,316 | 169 | 5,561 | 0 | 20,047 |

| HTRW Remedial Action | QUANTY | UOM | CREW ID | MANHOUR | LABOR | EQUIPMNT | MATERIAL | QUOTE | TOTAL COST |
|---|---|---|---|---|---|---|---|---|---|
| TOTAL SURFACE WATER COLLECT& CONTROL | | | | 1,002 | 14,316 | 169 | 5,561 | 0 | 20,047 |
| TOTAL HTRW Remedial Action | | | | 1,120 | 17,780 | 2,912 | 59,109 | 7,300 | 87,100 |
| TOTAL Temporary Facilities | | | | 1,120 | 17,780 | 2,912 | 59,109 | 7,300 | 87,100 |

| HTRW REMEDIAL ACTION | QUANTY | UOM | CREW ID | MANHOUR | LABOR | EQUIPMNT | MATERIAL | QUOTE | TOTAL COST |
|---|---|---|---|---|---|---|---|---|---|
| Health and Safety | | | | | | | | | |
| HTRW REMEDIAL ACTION | | | | | | | | | |
| OTHER | | | | | | | | | |
| OTHER | | | | | | | | | |
| Health & Safety Officer | | | | 1.00 | 32.57 | 0.00 | 0.00 | 0.00 | 32.57 |
| 9 hours/day | 1760.00 | HR | X-HSO | 1,760 | 57,326 | 0 | 0 | 0 | 57,326 |
| TRK,HWY,4X2,F250,3/4T,8600 GVW | | | | 0.00 | 0.00 | 7.31 | 0.00 | 0.00 | 7.31 |
| 4X2 3/4-TON PICK-UP, 8600 GVW, | 720.00 | HR | T50FO003 | 0 | 0 | 5,264 | 0 | 0 | 5,264 |
| Full Face Piece Air Purifying | | | | 0.00 | 0.00 | 0.00 | 150.92 | 0.00 | 150.92 |
| Respirators | 15.00 | EA | N/A | 0 | 0 | 0 | 2,264 | 0 | 2,264 |
| Safety Glasses | | | | 0.00 | 0.00 | 0.00 | 3.23 | 0.00 | 3.23 |
| | 15.00 | EA | | 0 | 0 | 0 | 49 | 0 | 49 |
| Hard hats | | | | 0.00 | 0.00 | 0.00 | 8.09 | 0.00 | 8.09 |
| | 15.00 | EA | | 0 | 0 | 0 | 121 | 0 | 121 |
| Work Gloves | | | | 0.00 | 0.00 | 0.00 | 1.30 | 0.00 | 1.30 |
| Approximately 1/2 work is | 5670.00 | PR | | 0 | 0 | 0 | 7,396 | 0 | 7,396 |
| modified "D" 15 men x 2 changes | | | | | | | | | |
| x 189 days= 5,670 change-outs. | | | | | | | | | |
| Cotton Gloves | | | | 0.00 | 0.00 | 0.00 | 0.36 | 0.00 | 0.36 |
| | 5670.00 | PR | | 0 | 0 | 0 | 2,017 | 0 | 2,017 |
| Nitrile Gloves | | | | 0.00 | 0.00 | 0.00 | 1.22 | 0.00 | 1.22 |
| | 5670.00 | PR | | 0 | 0 | 0 | 6,907 | 0 | 6,907 |
| Booties | | | | 0.00 | 0.00 | 0.00 | 2.70 | 0.00 | 2.70 |
| | 5670.00 | EA | | 0 | 0 | 0 | 15,281 | 0 | 15,281 |
| Tyveks | | | | 0.00 | 0.00 | 0.00 | 2.65 | 0.00 | 2.65 |
| | 5670.00 | EA | | 0 | 0 | 0 | 15,036 | 0 | 15,036 |
| Photoionization Detector | | | | 0.00 | 0.00 | 250.00 | 0.00 | 0.00 | 250.00 |
| | 36.00 | WK | | 0 | 0 | 9,000 | 0 | 0 | 9,000 |
| PID Support Accessories | | | | 0.00 | 0.00 | 0.00 | 53.90 | 0.00 | 53.90 |
| Span Gas | 1.00 | EA | | 0 | 0 | 0 | 54 | 0 | 54 |
| Photoionization Detector Printer | | | | 0.00 | 0.00 | 35.00 | 0.00 | 0.00 | 35.00 |
| | 36.00 | WK | | 0 | 0 | 1,260 | 0 | 0 | 1,260 |
| Noise Monitor | | | | 0.00 | 0.00 | 75.00 | 0.00 | 0.00 | 75.00 |
| | 36.00 | WK | | 0 | 0 | 2,700 | 0 | 0 | 2,700 |

| HTRW REMEDIAL ACTION | QUANTY | UOM | CREW ID | MANHOUR | LABOR | EQUIPMNT | MATERIAL | QUOTE | TOTAL COST |
|---|---|---|---|---|---|---|---|---|---|
| Personal Heat Stress Monitor | | | | 0.00 | 0.00 | 45.00 | 0.00 | 0.00 | 45.00 |
| | 36.00 | WK | | 0 | 0 | 1,620 | 0 | 0 | 1,620 |
| Tera Dust Monitor (2 ea) | | | | 0.00 | 0.00 | 0.00 | 242.55 | 0.00 | 242.55 |
| | 72.00 | WK | N/A | 0 | 0 | 0 | 17,464 | 0 | 17,464 |
| Industrial Hygienist | | | | 1.00 | 43.62 | 0.00 | 0.00 | 0.00 | 43.62 |
| to support Health and Safety Officer | 40.00 | HR | X-IH | 40 | 1,745 | 0 | 0 | 0 | 1,745 |
| Medical exams | | | | 0.00 | 0.00 | 0.00 | 539.00 | 0.00 | 539.00 |
| assume post exams only. | 15.00 | EA | | 0 | 0 | 0 | 8,085 | 0 | 8,085 |
| 5 Weather Readings (Purchase) | | | | 0.00 | 0.00 | 0.00 | 584.28 | 0.00 | 584.28 |
| 11" x 17". | 1.00 | EA | N/A | 0 | 0 | 0 | 584 | 0 | 584 |
| Portable Combustible Gas/Oxygen | | | | 0.00 | 0.00 | 0.00 | 334.18 | 0.00 | 334.18 |
| Indicator (Monthly Rental) | 9.00 | MO | N/A | 0 | 0 | 0 | 3,008 | 0 | 3,008 |
| Ambient Air Monitor | | | | 0.00 | 0.00 | 0.00 | 1684.91 | 0.00 | 1684.91 |
| (Monthly Rental) | 9.00 | MON | N/A | 0 | 0 | 0 | 15,164 | 0 | 15,164 |
| Health & Safety Officer | | | | 1.00 | 32.57 | 0.00 | 0.00 | 0.00 | 32.57 |
| | 80.00 | HR | X-HSO | 80 | 2,606 | 0 | 0 | 0 | 2,606 |
| TRK,HWY,4X2,F250,3/4T,8600 GVW | | | | 0.00 | 0.00 | 1.31 | 0.00 | 0.00 | 1.31 |
| REF. EP 1110-1-8 | 740.00 | HR | T50FO003 | 0 | 0 | 967 | 0 | 0 | 967 |
| 4X2 3/4-TON PICK-UP, 8600 GVW | | | | | | | | | |
| stanby half the time | | | | | | | | | |
| TOTAL OTHER | | | | 1,880 | 61,677 | 20,811 | 93,429 | 0 | 175,917 |
| TOTAL OTHER | | | | 1,880 | 61,677 | 20,811 | 93,429 | 0 | 175,917 |
| TOTAL HTRW REMEDIAL ACTION | | | | 1,880 | 61,677 | 20,811 | 93,429 | 0 | 175,917 |
| TOTAL Health and Safety | | | | 1,880 | 61,677 | 20,811 | 93,429 | 0 | 175,917 |

| | QUANTY UOM CREW ID | MANHOUR | LABOR | EQUIPMNT | MATERIAL | QUOTE | TOTAL COST |
|---|---|---|---|---|---|---|---|
| Clearing and Grubbing | | | | | | | |
| Clear Med Trees to 10"D | | 80.00 | 1258.87 | 1233.50 | 0.00 | 0.00 | 2492.37 |
| (25cm) Dia, Cut and Chip, estimate the chipped material will be blended with the coal tar deposist material as part of the pre-processing. | 7.00 ACR COMCA | 560 | 8,812 | 8,635 | 0 | 0 | 17,447 |
| Clear & Grub Med Stumps to 10" D | | 20.00 | 436.44 | 897.55 | 0.00 | 0.00 | 1333.99 |
| (25cm) Dia, Include Removal | 7.00 ACR COETV | 140 | 3,055 | 6,283 | 0 | 0 | 9,338 |
| TOTAL Clearing and Grubbing | | 700 | 11,867 | 14,917 | 0 | 0 | 26,785 |

05. Install & Remove Haul Road

| | QUANTY | UOM | CREW ID | MANHOUR | LABOR | EQUIPMNT | MATERIAL | QUOTE | TOTAL COST |
|---|---|---|---|---|---|---|---|---|---|
| Install & Remove Haul Road | | | | | | | | | |
| Graded Crushed Agg Rdwy Base Crs | | | | 0.26 | 6.91 | 7.70 | 4.46 | 0.00 | 19.07 |
| 9,400 lf x 30' + 5 | 5778.00 | CY | XSABA | 1,479 | 39,942 | 44,462 | 25,784 | 0 | 110,188 |
| turnarounds (60' x 100')= | | | | | | | | | |
| 312,000 s.f. x 6"= 5,778 c.y. | | | | | | | | | |
| Filter fabric | | | | 0.00 | 0.00 | 0.00 | 0.00 | 0.30 | 0.30 |
| | 312000 | SF | | 0 | 0 | 0 | 0 | 93,600 | 93,600 |
| Remove haul road and load | | | | 0.12 | 2.47 | 1.45 | 0.00 | 0.00 | 3.93 |
| | 5778.00 | CY | CODEG | 700 | 14,295 | 8,398 | 0 | 0 | 22,694 |
| Haul,12CY (91M3) Trk, 6 Mi(10Km) | | | | 0.04 | 0.86 | 1.49 | 0.00 | 0.00 | 2.34 |
| 40 MPH (60 Km/Hr), 2.1 Cycles/Hr | 5778.00 | CY | COEID | 236 | 4,945 | 8,601 | 0 | 0 | 13,547 |
| 2.1 Cycles/Hr | | | | | | | | | |
| TOTAL Install & Remove Haul Road | | | | 2,415 | 59,183 | 61,461 | 25,784 | 93,600 | 240,028 |

06. Sheetpile (cofferdam)

| | QUANTY | UOM | CREW ID | MANHOUR | LABOR | EQUIPMNT | MATERIAL | QUOTE | TOTAL COST |
|---|---|---|---|---|---|---|---|---|---|
| Sheetpile (cofferdam) | | | | | | | | | |
| Shoring for 25'(8M) Exc, 38 PSF | | | | 9.70 | 205.87 | 213.55 | 758.46 | 0.00 | 1177.88 |
| Steel Sheeting, Pull and Salvage | 119.00 | TON | CPIDV | 1,154 | 28,588 | 29,655 | 105,326 | 0 | 163,569 |
| 50' wide cofferdams, 5 cofferdams, 25' length, use 6250 s.f. x 38 lb/s.f.= 119 ton. | | | | | | | | | |
| TOTAL Sheetpile (cofferdam) | | | | 1,154 | 28,588 | 29,655 | 105,326 | 0 | 163,569 |

| Diversion piping and pumps | QUANTY UOM | CREW ID | MANHOUR | LABOR | EQUIPMNT | MATERIAL | QUOTE | TOTAL COST |
|---|---|---|---|---|---|---|---|---|
| Creek Diversion | | | | | | | | |
| Diversion piping and pumps | | | | | | | | |
| Assume creek will be diverted in three segments using 4 16" diesel powered lift pumps (1 pump not in line) and 8,500 ft. of 21" HDPE diversion piping. After the first reach is completed the pumps and diversion piping will be removed and reset for second segment and then the third. | | | | | | | | |
| Assume 2 pump operators will be required 16 hours/day for 3 months. | | | | | | | | |
| 16" high lift pump | | | 0.00 | 0.00 | 0.00 | 8758.75 | 0.00 | 8758.75 |
| trailer mounted humpback pump, 13,200 gpm. | 4.00 EA | | 0 | 0 | 0 | 35,035 | 0 | 35,035 |
| Quote: Crisfulli Pump Company, Inc., Glendive, Montana, 2/17/95, 1-800-442-pump assume operation and maintainence equal to salvage value. | | | | | | | | |
| Diesel engine, skid mounted | | | 0.00 | 0.00 | 2500.00 | 0.00 | 0.00 | 2500.00 |
| skid mounted | 12.00 MO | | 0 | 0 | 30,000 | 0 | 0 | 30,000 |
| Assume 3 months x 4 engines= 12 equivelent months. | | | | | | | | |
| Diesel engine, O&M costs | | | 0.00 | 0.00 | 30.00 | 0.00 | 0.00 | 30.00 |
| skid mounted | 8640.00 HRS | | 0 | 0 | 259,200 | 0 | 0 | 259,200 |
| Assume 3 months x 4 engines= 12 equivalent months. | | | | | | | | |
| Eq Oper, Light | | | 1.00 | 20.98 | 0.00 | 0.00 | 0.00 | 20.98 |
| | 2880.00 HR | B-EQOPRLT | 2,880 | 60,421 | 0 | 0 | 0 | 60,421 |
| Deploy & remove 18" polyeth pipe | | | 0.20 | 3.21 | 2.48 | 0.00 | 0.00 | 5.69 |
| | 8500.00 LF | CODEX | 1,700 | 27,281 | 21,080 | 0 | 0 | 48,361 |
| 21"(61cm) Corr Polyethylene Pipe | | | 0.20 | 3.21 | 2.48 | 14.57 | 0.00 | 20.26 |
| | 8500.00 LF | CODEX | 1,700 | 27,281 | 21,080 | 123,884 | 0 | 172,245 |
| TOTAL Diversion piping and pumps | | | 6,280 | 114,982 | 331,360 | 158,919 | 0 | 605,261 |

| Dewatering segment | QUANTY | UOM | CREW ID | MANHOUR | LABOR | EQUIPMNT | MATERIAL | QUOTE | TOTAL COST |
|---|---|---|---|---|---|---|---|---|---|
| Dewatering segment | | | | | | | | | |
| Assume dewatering three segments and discharge back to creek, 8,500' x 50' width x 5' depth x 7.48 gal/c.f.=15895 KGA / 5,550 gal/ min= 48 hours. Assume 500' of pipe and accessories total. | | | | | | | | | |
| 12" Goodwin pump, rental cost | | | | 0.00 | 0.00 | 0.00 | 3557.40 | 0.00 | 3557.40 |
| Quote from Lee Mathews rental, self-priming, diesel powered, skid-mounted, $3,300 month, | 1.00 | EA | | 0 | 0 | 0 | 3,557 | 0 | 3,557 |
| 12" Goodwin pump, O&M costs | | | | 0.00 | 0.00 | 28.80 | 0.00 | 0.00 | 28.80 |
| | 48.00 | HRS | | 0 | 0 | 1,382 | 0 | 0 | 1,382 |
| Eq Oper, Light | | | | 1.00 | 20.98 | 0.00 | 0.00 | 0.00 | 20.98 |
| | 48.00 | HR | B-EQOPRLT | 48 | 1,007 | 0 | 0 | 0 | 1,007 |
| 21"(61cm) Corr Polyethylene Pipe | | | | 0.20 | 3.21 | 2.48 | 14.57 | 0.00 | 20.26 |
| | 500.00 | LF | CODEX | 100 | 1,605 | 1,240 | 7,287 | 0 | 10,132 |
| TOTAL Dewatering segment | | | | 148 | 2,612 | 2,622 | 10,845 | 0 | 16,079 |
| TOTAL Creek Diversion | | | | 6,428 | 117,594 | 333,982 | 169,763 | 0 | 621,340 |

| Channel excavation | QUANTY | UOM | CREW ID | MANHOUR | LABOR | EQUIPMNT | MATERIAL | QUOTE | TOTAL COST |
|---|---|---|---|---|---|---|---|---|---|
| Channel Excavation | | | | | | | | | |
| Channel excavation | | | | | | | | | |
| Assume the following crew will excavate 14,200 c.y. at a rate of 60 c.y./hr. | | | | | | | | | |
| 1- Foreman | | | | | | | | | |
| 3- Equipment operators | | | | | | | | | |
| 2- Laborers | | | | | | | | | |
| 1- Pick-up | | | | | | | | | |
| 1- 1.5 c.y. excavator, crawlered | | | | | | | | | |
| 1- .88 c.y. excavator, crawlered | | | | | | | | | |
| 1- D-7 Dozer | | | | | | | | | |
| Eq Oper, Medium | | | | 1.00 | 23.03 | 0.00 | 0.00 | 0.00 | 23.03 |
| | 710.00 | HR | B-EQOPRMED | 710 | 16,350 | 0 | 0 | 0 | 16,350 |
| Laborer (Semi-Skilled) | | | | 1.00 | 14.18 | 0.00 | 0.00 | 0.00 | 14.18 |
| | 473.33 | HR | B-LABORER | 473 | 6,711 | 0 | 0 | 0 | 6,711 |
| Foreman | | | | 1.00 | 24.49 | 0.00 | 0.00 | 0.00 | 24.49 |
| | 236.67 | HR | B-FOREMAN | 237 | 5,797 | 0 | 0 | 0 | 5,797 |
| HYD EXCAV, CRWLR, 0.88 CY BKT | | | | 0.00 | 0.00 | 35.49 | 0.00 | 0.00 | 35.49 |
| | 236.67 | HR | H25JD007 | 0 | 0 | 8,400 | 0 | 0 | 8,400 |
| TRK,HWY, 8,800GVW,4X4, 3/4T-PKUP | | | | 0.00 | 0.00 | 8.70 | 0.00 | 0.00 | 8.70 |
| REF. EP 1110-1-8 | 236.67 | HR | T50FO004 | 0 | 0 | 2,058 | 0 | 0 | 2,058 |
| 4X4 3/4-TON PICK-UP, 8800 GVW | | | | | | | | | |
| HYD EXCAV, CRWLR, 1.50 CY BKT | | | | 0.00 | 0.00 | 43.93 | 0.00 | 0.00 | 43.93 |
| | 473.33 | HR | H25LB005 | 0 | 0 | 20,796 | 0 | 0 | 20,796 |
| BLADE, UNIVERSAL, HYDR, D-7 | | | | 0.00 | 0.00 | 6.53 | 0.00 | 0.00 | 6.53 |
| (ADD D-7 TRACTOR DOZER) | 236.67 | HR | T10CA013 | 0 | 0 | 1,545 | 0 | 0 | 1,545 |
| DOZER,CWLR, D-7H,PS | | | | 0.00 | 0.00 | 65.44 | 0.00 | 0.00 | 65.44 |
| (ADD BLADE & ATTACHMENTS) | 236.67 | HR | T15CA013 | 0 | 0 | 15,488 | 0 | 0 | 15,488 |
| TOTAL Channel excavation | | | | 1,420 | 28,858 | 48,287 | 0 | 0 | 77,144 |

| Sampling and Analysis | QUANTY | UOM | CREW ID | MANHOUR | LABOR | EQUIPMNT | MATERIAL | QUOTE | TOTAL COST |
|---|---|---|---|---|---|---|---|---|---|
| Sampling and Analysis | | | | | | | | | |
| SAMPLING SOIL & SEDIMENT | | | | | | | | | |
| Pre-excavation and during | | | | | | | | | |
| Sampling technician (2 ea) | | | | 1.00 | 14.18 | 0.00 | 0.00 | 0.00 | 14.18 |
| assume 2 sampling tech's can | 16.00 | HR | B-LABORER | 16 | 227 | 0 | 0 | 0 | 227 |
| take 2 samples/hour. | | | | | | | | | |
| 15 samples /2 use 16 hours | | | | | | | | | |
| Mobilize/Demobilize 2 Man | | | | 0.00 | 0.00 | 0.00 | 431.20 | 0.00 | 431.20 |
| Sampling Crew, 100 Miles | 1.00 | EA | N/A | 0 | 0 | 0 | 431 | 0 | 431 |
| TOTAL Pre-excavation and during | | | | 16 | 227 | 0 | 431 | 0 | 658 |
| Post-excavation (base) | | | | | | | | | |
| TOTAL Post-excavation (base) | | | | 0 | 0 | 0 | 0 | 0 | 0 |
| TOTAL SAMPLING SOIL & SEDIMENT | | | | 16 | 227 | 0 | 431 | 0 | 658 |
| CHEMICAL LABORATORY ANALYSIS | | | | | | | | | |
| Pre excavation and during | | | | | | | | | |
| QTY includes 30% for QA/QC | | | | | | | | | |
| Semivolatile Organics (8270) | | | | 0.00 | 0.00 | 0.00 | 253.33 | 0.00 | 253.33 |
| | 20.00 | EA | N/A | 0 | 0 | 0 | 5,067 | 0 | 5,067 |
| Mercury (7041) | | | | 0.00 | 0.00 | 0.00 | 26.95 | 0.00 | 26.95 |
| | 20.00 | EA | N/A | 0 | 0 | 0 | 539 | 0 | 539 |
| Volatile Organic Analysis (8240) | | | | 0.00 | 0.00 | 0.00 | 280.28 | 0.00 | 280.28 |
| | 20.00 | EA | N/A | 0 | 0 | 0 | 5,606 | 0 | 5,606 |
| Pesticides/PCBs (8080) | | | | 0.00 | 0.00 | 0.00 | 226.38 | 0.00 | 226.38 |
| | 20.00 | EA | N/A | 0 | 0 | 0 | 4,528 | 0 | 4,528 |
| TAL Metals (6010/7000s) | | | | 0.00 | 0.00 | 0.00 | 253.33 | 0.00 | 253.33 |
| | 20.00 | EA | N/A | 0 | 0 | 0 | 5,067 | 0 | 5,067 |
| TOTAL Pre excavation and during | | | | 0 | 0 | 0 | 20,805 | 0 | 20,805 |
| TOTAL CHEMICAL LABORATORY ANALYSIS | | | | 0 | 0 | 0 | 20,805 | 0 | 20,805 |
| TOTAL Sampling and Analysis | | | | 16 | 227 | 0 | 21,237 | 0 | 21,463 |

| Sampling and Analysis | QUANTY | UOM | CREW ID | MANHOUR | LABOR | EQUIPMNT | MATERIAL | QUOTE | TOTAL COST |
|---|---|---|---|---|---|---|---|---|---|
| TOTAL Channel Excavation | | | | 1,436 | 29,084 | 48,287 | 21,237 | 0 | 98,608 |

| Haul to plant site | QUANTY | UOM | CREW ID | MANHOUR | LABOR | EQUIPMNT | MATERIAL | QUOTE | TOTAL COST |
|---|---|---|---|---|---|---|---|---|---|
| Haul Material to Site | | | | | | | | | |
| Haul to plant site | | | | | | | | | |
| Haul,12 CY (91M3) Trk, 1 Mi(2Km) | | | | 0.02 | 0.43 | 0.74 | 0.00 | 0.00 | 1.17 |
| 20 MPH (30 Km/Hr), 4.2 Cycles/Hr | 14200 | CY | COEID | 290 | 6,076 | 10,569 | 0 | 0 | 16,645 |
| 4.2 Cycles/Hr | | | | | | | | | |
| TOTAL Haul to plant site | | | | 290 | 6,076 | 10,569 | 0 | 0 | 16,645 |
| TOTAL Haul Material to Site | | | | 290 | 6,076 | 10,569 | 0 | 0 | 16,645 |

| Material preprocessing | QUANTY | UOM | CREW ID | MANHOUR | LABOR | EQUIPMNT | MATERIAL | QUOTE | TOTAL COST |
|---|---|---|---|---|---|---|---|---|---|
| Material Preprocessing | | | | | | | | | |
| Material is blended with wood chips to dry prior to off-site disposal. | | | | | | | | | |
| Material preprocessing | | | | | | | | | |
| Eq Oper, Medium | | | | 1.00 | 23.03 | 0.00 | 0.00 | 0.00 | 23.03 |
| | 710.00 | HR | B-EQOPRMED | 710 | 16,350 | 0 | 0 | 0 | 16,350 |
| Laborer (Semi-Skilled) | | | | 1.00 | 14.18 | 0.00 | 0.00 | 0.00 | 14.18 |
| | 473.33 | HR | B-LABORER | 473 | 6,711 | 0 | 0 | 0 | 6,711 |
| Foreman | | | | 1.00 | 24.49 | 0.00 | 0.00 | 0.00 | 24.49 |
| | 236.67 | HR | B-FOREMAN | 237 | 5,797 | 0 | 0 | 0 | 5,797 |
| HYD EXCAV, CRWLR, 0.88 CY BKT | | | | 0.00 | 0.00 | 35.49 | 0.00 | 0.00 | 35.49 |
| | 236.67 | HR | H25JD007 | 0 | 0 | 8,400 | 0 | 0 | 8,400 |
| TRK,HWY, 8,800GVW,4X4, 3/4T-PKUP | | | | 0.00 | 0.00 | 8.70 | 0.00 | 0.00 | 8.70 |
| REF. EP 1110-1-8 | 236.67 | HR | T50FO004 | 0 | 0 | 2,058 | 0 | 0 | 2,058 |
| 4X4 3/4-TON PICK-UP, 8800 GVW | | | | | | | | | |
| HYD EXCAV, CRWLR, 1.50 CY BKT | | | | 0.00 | 0.00 | 43.93 | 0.00 | 0.00 | 43.93 |
| | 473.33 | HR | H25LB005 | 0 | 0 | 20,796 | 0 | 0 | 20,796 |
| LDR,FE, CRWLR, 2.00 CY | | | | 0.00 | 0.00 | 41.99 | 0.00 | 0.00 | 41.99 |
| | 236.67 | HR | L35CA005 | 0 | 0 | 9,938 | 0 | 0 | 9,938 |
| 30 HP BLENDER, 150 CF MIXING | | | | 0.00 | 0.00 | 31.00 | 0.00 | 0.00 | 31.00 |
| CAPACITY | 236.67 | HR | | 0 | 0 | 7,337 | 0 | 0 | 7,337 |
| LDR,BELT, 24"X50', 355 TON/HR | | | | 0.00 | 0.00 | 6.18 | 0.00 | 0.00 | 6.18 |
| | 236.67 | HR | L30KL001 | 0 | 0 | 1,463 | 0 | 0 | 1,463 |
| TOTAL Material preprocessing | | | | 1,420 | 28,858 | 49,992 | 0 | 0 | 78,849 |
| TOTAL Material Preprocessing | | | | 1,420 | 28,858 | 49,992 | 0 | 0 | 78,849 |

| REVEGETATION AND PLANTING | QUANTY | UOM | CREW ID | MANHOUR | LABOR | EQUIPMNT | MATERIAL | QUOTE | TOTAL COST |
|---|---|---|---|---|---|---|---|---|---|
| Site Restoration | | | | | | | | | |
| REVEGETATION AND PLANTING | | | | | | | | | |
| Area grading | | | | | | | | | |
| Rough Terrain Clearing w/Dozer | | | | 2.02 | 46.82 | 192.09 | 0.00 | 0.00 | 238.91 |
| 300 HP | 8.00 | ACR | CODTK | 16 | 437 | 1,793 | 0 | 0 | 2,230 |
| Soil Material | | | | | | | | | |
| TOTAL Area grading | | | | 16 | 437 | 1,793 | 0 | 0 | 2,230 |
| Seeding and Mulching | | | | | | | | | |
| Tilling | | | | | | | | | |
| Production: 2 acres/day | | | | | | | | | |
| Eq Oper, Light | | | | 1.00 | 20.98 | 0.00 | 0.00 | 0.00 | 20.98 |
| | 32.00 | HR | B-EQOPRLT | 32 | 783 | 0 | 0 | 0 | 783 |
| TRACTOR,WH,FARM, JD-2755, 2WD | | | | 0.00 | 0.00 | 9.32 | 0.00 | 0.00 | 9.32 |
| REF. EP 1110-1-8 | 32.00 | HR | T25JD004 | 0 | 0 | 348 | 0 | 0 | 348 |
| INDUSTRIAL 2WD (NO ATTACHMENTS) | | | | | | | | | |
| Disc | | | | 0.00 | 0.00 | 5.00 | 0.00 | 0.00 | 5.00 |
| | 32.00 | HR | | 0 | 0 | 187 | 0 | 0 | 187 |
| TOTAL Tilling | | | | 32 | 783 | 535 | 0 | 0 | 1,318 |
| Seed | | | | | | | | | |
| Eq Oper, Light | | | | 1.00 | 20.98 | 0.00 | 0.00 | 0.00 | 20.98 |
| | 21.33 | HR | B-EQOPRLT | 21 | 522 | 0 | 0 | 0 | 522 |
| Laborer (Semi-Skilled) | | | | 1.00 | 14.18 | 0.00 | 0.00 | 0.00 | 14.18 |
| | 21.33 | HR | B-LABORER | 21 | 353 | 0 | 0 | 0 | 353 |
| TRACTOR,WH,FARM, JD-2755, 2WD | | | | 0.00 | 0.00 | 9.32 | 0.00 | 0.00 | 9.32 |
| REF. EP 1110-1-8 | 21.33 | HR | T25JD004 | 0 | 0 | 232 | 0 | 0 | 232 |
| INDUSTRIAL 2WD (NO ATTACHMENTS) | | | | | | | | | |
| Seeder | | | | 0.00 | 0.00 | 7.35 | 0.00 | 0.00 | 7.35 |
| | 21.33 | HR | | 0 | 0 | 183 | 0 | 0 | 183 |
| Seed | | | | 0.00 | 0.00 | 0.00 | 32.34 | 0.00 | 32.34 |
| 15 lb/acre | 8.00 | ACR | | 0 | 0 | 0 | 302 | 0 | 302 |
| fertilizer | | | | 0.00 | 0.00 | 0.00 | 28.03 | 0.00 | 28.03 |
| | 8.00 | ACR | | 0 | 0 | 0 | 262 | 0 | 262 |

| REVEGETATION AND PLANTING | QUANTY UOM | CREW ID | MANHOUR | LABOR | EQUIPMNT | MATERIAL | QUOTE | TOTAL COST |
|---|---|---|---|---|---|---|---|---|
| TOTAL Seed | | | 43 | 875 | 415 | 564 | 0 | 1,854 |
| Mulch | | | | | | | | |
| Production: 2 acres/day | | | | | | | | |
| Eq Oper, Light | | | 1.00 | 20.98 | 0.00 | 0.00 | 0.00 | 20.98 |
| | 32.00 HR | B-EQOPRLT | 32 | 783 | 0 | 0 | 0 | 783 |
| Laborer (Semi-Skilled) | | | 1.00 | 14.18 | 0.00 | 0.00 | 0.00 | 14.18 |
| | 64.00 HR | B-LABORER | 64 | 1,059 | 0 | 0 | 0 | 1,059 |
| TRACTOR,WH,FARM, JD-2755, 2WD | | | 0.00 | 0.00 | 9.32 | 0.00 | 0.00 | 9.32 |
| REF. EP 1110-1-8 | 32.00 HR | T25JD004 | 0 | 0 | 348 | 0 | 0 | 348 |
| INDUSTRIAL 2WD (NO ATTACHMENTS) | | | | | | | | |
| Power mulcher | | | 0.00 | 0.00 | 13.52 | 0.00 | 0.00 | 13.52 |
| | 32.00 HR | L15EX009 | 0 | 0 | 505 | 0 | 0 | 505 |
| Mulch, straw | | | 0.00 | 0.00 | 0.00 | 360.05 | 0.00 | 360.05 |
| 2.5 ton/acre = 5,000 lb/acre | 8.00 ACR | | 0 | 0 | 0 | 3,361 | 0 | 3,361 |
| assume 30lb/bale, need 167 | | | | | | | | |
| bales at $2.00/bale= $334/acre. | | | | | | | | |
| TOTAL Mulch | | | 96 | 1,842 | 853 | 3,361 | 0 | 6,057 |
| TOTAL Seeding and Mulching | | | 171 | 3,501 | 1,803 | 3,925 | 0 | 9,229 |
| TOTAL REVEGETATION AND PLANTING | | | 187 | 3,938 | 3,596 | 3,925 | 0 | 11,459 |
| TOTAL Site Restoration | | | 187 | 3,938 | 3,596 | 3,925 | 0 | 11,459 |
| TOTAL Feasibility estimate for: | | | 24,189 | 673,568 | 591,975 | 483,949 | 261,300 | 2,010,792 |

## ALTERNATIVE 2

## RE-ROUTING AND CONTAINMENT

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Feasibility estimate for:
" Re-route and containment" ,
Tennessee products site,
Operable unit 1, Chattanooga
Creek, TN

Designed By: CENWK
Estimated By: CENWK-ED-C

Prepared By: Tom Zimmerman
Price level date: Oct 1999

Preparation Date: 06/02/99
Effective Date of Pricing: 10/01/99

Sales Tax: 7.80%



M C A C E S G O L D E D I T I O N
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Release 5.30A

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Site Description:

The Tennessee Products Site is located in Chattanooga, TN on an approximate 2.5 mile stretch of the Chattanooga Creek where coal tar material was deposited in the creek and surrounding areas.

Containment Description:

The work consists of clearing and grubbing 28 acres for the proposed realignment, haul road network, stockpile area, and diversion piping; Installation and removal of 17,600 lf.,24' wide 10" rock haul road and 457,600 s.f. of filter fabric; Installation of 200 lf of cofferdam (sheetpiling) 5,000 s.f.; Creek Diversion using a four 12" lift pumps and HDPE piping dewatering operation and removing sediments in 2 segments where proposed realignment is in existing channel; Excavation of 92,400 c.y. by scraper for realignment and stockpiling; Loading from stockpile and backfilling and traffic compacting in old channel working from within channel, 92,400 c.y.; Placement by crane of 12,200 ton of quarry run stone slope protection for new channel slopes; Insitu Stabilization of 14,200 c.y. of contaminated sediments and coal tar deposits which includes mobilization/demobilization and demonstration test; Sampling and analysis of proposed realignment channel.

25% overhead, 8% profit, 9.9% escalation, 2% engineering and design applied.

23% budgetary cost factor applied. Consists of 15% bid contingency, 6% Construction Management, 2% engineering during construction and Lab QA.

No construction contingency or design contingency was applied as this was considered in calculating the quantities.

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SUMMARY REPORTS SUMMARY PAGE



DETAILED ESTIMATE DETAIL PAGE



No Backup Reports...

* * * END TABLE OF CONTENTS * * *

** PROJECT OWNER SUMMARY - Bid Item (Rounded to 100's) **

| | | QUANTITY | UOM | CONTRACT | ESCALATN | E&D | BUDGET | TOTAL COST | UNIT COST |
|---|---|---|---|---|---|---|---|---|---|
| 01 | Clearing and Grubbing | 28.00 | ACR | 146,100 | 14,500 | 3,200 | 37,700 | 201,400 | 7193.57 |
| 02 | Install & remove haul road | 17600.00 | LF | 617,400 | 61,100 | 13,600 | 159,200 | 851,200 | 48.36 |
| 03 | Sheetpile (cofferdam) | 200.00 | LF | 173,500 | 17,200 | 3,800 | 44,700 | 239,300 | 1196.32 |
| 04 | Creek diversion | 3400.00 | LF | 442,300 | 43,800 | 9,700 | 114,000 | 609,800 | 179.37 |
| 05 | Excavate, haul, place in channel | 3700.00 | CY | 46,300 | 4,600 | 1,000 | 11,900 | 63,800 | 17.24 |
| 06 | Realignment excavation | 92400.00 | CY | 692,900 | 68,600 | 15,200 | 178,700 | 955,400 | 10.34 |
| 07 | In-situ stabilization | 14200.00 | CY | 1,936,200 | 191,700 | 42,600 | 499,200 | 2,669,600 | 188.00 |
| 08 | Slope protection | 12200.00 | TON | 269,100 | 26,600 | 5,900 | 69,400 | 371,100 | 30.41 |
| 09 | Backfill | 92400.00 | CY | 471,200 | 46,600 | 10,400 | 121,500 | 649,700 | 7.03 |
| 10 | Sampling and Analysis | | | 34,800 | 3,400 | 800 | 9,000 | 47,900 | |
| 11 | Site Restoration | | | 32,700 | 3,200 | 700 | 8,400 | 45,100 | |
| TOTAL | Feasibility estimate for: | 1.00 | EA | 4,862,400 | 481,400 | 106,900 | 1,253,700 | 6,704,300 | 6704344 |

** PROJECT INDIRECT SUMMARY - Bid Item (Rounded to 100's) **

| | | QUANTITY | UOM | DIRECT | OVERHEAD | PROFIT | BOND | TOTAL COST | UNIT COST |
|---|---|---|---|---|---|---|---|---|---|
| 01 | Clearing and Grubbing | 28.00 | ACR | 107,100 | 26,800 | 10,700 | 1,400 | 146,100 | 5217.25 |
| 02 | Install & remove haul road | 17600.00 | LF | 452,800 | 113,200 | 45,300 | 6,100 | 617,400 | 35.08 |
| 03 | Sheetpile (cofferdam) | 200.00 | LF | 127,300 | 31,800 | 12,700 | 1,700 | 173,500 | 867.65 |
| 04 | Creek diversion | 3400.00 | LF | 324,400 | 81,100 | 32,400 | 4,400 | 442,300 | 130.09 |
| 05 | Excavate, haul, place in channel | 3700.00 | CY | 33,900 | 8,500 | 3,400 | 500 | 46,300 | 12.50 |
| 06 | Realignment excavation | 92400.00 | CY | 508,200 | 127,100 | 50,800 | 6,900 | 692,900 | 7.50 |
| 07 | In-situ stabilization | 14200.00 | CY | 1,420,000 | 355,000 | 142,000 | 19,200 | 1,936,200 | 136.35 |
| 08 | Slope protection | 12200.00 | TON | 197,400 | 49,300 | 19,700 | 2,700 | 269,100 | 22.06 |
| 09 | Backfill | 92400.00 | CY | 345,600 | 86,400 | 34,600 | 4,700 | 471,200 | 5.10 |
| 10 | Sampling and Analysis | | | 25,500 | 6,400 | 2,600 | 300 | 34,800 | |
| 11 | Site Restoration | | | 24,000 | 6,000 | 2,400 | 300 | 32,700 | |
| TOTAL | Feasibility estimate for: | 1.00 | EA | 3,566,100 | 891,500 | 356,600 | 48,100 | 4,862,400 | 4862430 |
| | ESCALATION | | | | | | | 481,400 | |
| | SUBTOTAL | | | | | | | 5,343,800 | |
| | E&D 2% | | | | | | | 106,900 | |
| | SUBTOTAL | | | | | | | 5,450,700 | |
| | BUDGET 23% | | | | | | | 1,253,700 | |
| | TOTAL INCL OWNER COSTS | | | | | | | 6,704,300 | |

** PROJECT DIRECT SUMMARY - Bid Item (Rounded to 100's) **

| | | QUANTITY | UOM | MANHOUR | LABOR | EQUIPMNT | MATERIAL | QUOTE | TOTAL COST | UNIT COST |
|---|---|---|---|---|---|---|---|---|---|---|
| 01 | Clearing and Grubbing | 28.00 | ACR | 2,800 | 47,500 | 59,700 | 0 | 0 | 107,100 | 3826.37 |
| 02 | Install & remove haul road | 17600.00 | LF | 5,300 | 131,000 | 134,200 | 50,300 | 137,300 | 452,800 | 25.73 |
| 03 | Sheetpile (cofferdam) | 200.00 | LF | 900 | 23,200 | 24,100 | 79,900 | 0 | 127,300 | 636.34 |
| 04 | Creek diversion | 3400.00 | LF | 2,700 | 53,500 | 254,300 | 16,600 | 0 | 324,400 | 95.41 |
| 05 | Excavate, haul, place in channel | 3700.00 | CY | 100 | 1,300 | 2,300 | 0 | 30,200 | 33,900 | 9.17 |
| 06 | Realignment excavation | 92400.00 | CY | 0 | 0 | 0 | 0 | 508,200 | 508,200 | 5.50 |
| 07 | In-situ stabilization | 14200.00 | CY | 0 | 0 | 0 | 0 | 1,420,000 | 1,420,000 | 100.00 |
| 08 | Slope protection | 12200.00 | TON | 1,600 | 33,600 | 19,200 | 144,700 | 0 | 197,400 | 16.18 |
| 09 | Backfill | 92400.00 | CY | 0 | 0 | 0 | 0 | 345,600 | 345,600 | 3.74 |
| 10 | Sampling and Analysis | | | 0 | 0 | 0 | 0 | 25,500 | 25,500 | |
| 11 | Site Restoration | | | 0 | 0 | 0 | 0 | 24,000 | 24,000 | |
| TOTAL | Feasibility estimate for: | 1.00 | EA | 13,400 | 290,100 | 493,800 | 291,500 | 2,490,800 | 3,566,100 | 3566138 |

| | |
|---|---|
| OVERHEAD | 891,500 |
| SUBTOTAL | 4,457,700 |
| PROFIT | 356,600 |
| SUBTOTAL | 4,814,300 |
| BOND | 48,100 |
| TOTAL INCL INDIRECTS | 4,862,400 |
| ESCALATION | 481,400 |
| SUBTOTAL | 5,343,800 |
| E&D 2% | 106,900 |
| SUBTOTAL | 5,450,700 |
| BUDGET 23% | 1,253,700 |
| TOTAL INCL OWNER COSTS | 6,704,300 |

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No errors detected...

* * * END OF ERROR REPORT * * *

Project Distributed Costs

| General conditions | QUANTY | UOM | CREW ID | OUTPUT | MANHOUR | LABOR | EQUIPMNT | MATERIAL | QUOTE | TOTAL COST | UNIT COST |
|---|---|---|---|---|---|---|---|---|---|---|---|

General conditions

The %Overhead column of 25% is taken as a percentage of the direct costs and consists of field overhead; home office overhead; supervision; engineering and office personnel; contractor quality control; pollution insurance; Builders Risk and Public Liability Insurance; bond; health and safety costs.

01. Clearing and Grubbing

| | QUANTY | UOM | CREW ID | OUTPUT | MANHOUR | LABOR | EQUIPMNT | MATERIAL | QUOTE | TOTAL COST | UNIT COST |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Clearing and Grubbing | | | | | | | | | | | |
| Clear Med Trees to 10"D (25cm) Dia, Cut and Chip, Estimate salavage value for chipped material equal to transportation cost. | 28.00 | ACR | COMCA | 0.08 | 2,240 | 35,248 | 34,538 | 0 | 0 | 69,786 | 2492.37 |
| Clear & Grub Med Stumps t o 10" D (25cm) Dia, Include Removal | 28.00 | ACR | COETV | 0.15 | 560 | 12,220 | 25,132 | 0 | 0 | 37,352 | 1333.99 |
| Clearing and Grubbing | 28.00 | ACR | | | 2,800 | 47,469 | 59,670 | 0 | 0 | 107,138 | 3826.37 |

02. Install & remove haul road

| | QUANTY | UOM | CREW ID | OUTPUT | MANHOUR | LABOR | EQUIPMNT | MATERIAL | QUOTE | TOTAL COST | UNIT COST |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Install & remove haul road | | | | | | | | | | | |
| Graded Crushed Agg Rdwy Base Crs | 13037 | CY | XSABA | 31.25 | 3,337 | 90,122 | 100,320 | 50,313 | 0 | 240,755 | 18.47 |
| Filter fabric installed | 457600 | SF | | 0.00 | 0 | 0 | 0 | 0 | 137,280 | 137,280 | 0.30 |
| Remove gravel road and load | 13037 | CY | CODEG | 12.38 | 1,580 | 32,255 | 18,949 | 0 | 0 | 51,204 | 3.93 |
| Haul,12CY (91M3) Trk, 6 Mi(10Km) 40 MPH (60 Km/Hr), 2.1 Cycles/Hr 2.1 Cycles/Hr | 10037 | CY | COEID | 24.50 | 410 | 8,591 | 14,941 | 0 | 0 | 23,532 | 2.34 |
| Install & remove haul roa | 17600 | LF | | | 5,327 | 130,968 | 134,210 | 50,313 | 137,280 | 452,771 | 25.73 |

03. Sheetpile (cofferdam)

| | QUANTY | UOM | CREW ID | OUTPUT | MANHOUR | LABOR | EQUIPMNT | MATERIAL | QUOTE | TOTAL COST | UNIT COST |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Sheetpile (cofferdam) | | | | | | | | | | | |
| Shoring for 25'(8M) Exc, 38 PSF<br>Steel Sheeting, Pull and Salvage<br>Assume 25' length x 200'= 5,000 s.f. x 38 lb/s.f./2000 lb/ton= 95 ton. | 95.00 | TON | CPIDV | 0.83 | 921 | 23,234 | 24,101 | 79,933 | 0 | 127,268 | 1339.66 |
| Sheetpile (cofferdam) | 200.00 | LF | | | 921 | 23,234 | 24,101 | 79,933 | 0 | 127,268 | 636.34 |

| Creek diversion | QUANTY | UOM | CREW ID | OUTPUT | MANHOUR | LABOR | EQUIPMNT | MATERIAL | QUOTE | TOTAL COST | UNIT COST |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Creek diversion | | | | | | | | | | | |
| Creek diversion | | | | | | | | | | | |
| PUMP,CENTRF,DW,12"D,4410G PM/60'H | 17280 | HR | P60GF006 | 1.00 | 0 | 0 | 232,359 | 0 | 0 | 232,359 | 13.45 |
| 4 pumps, 3 inline operate 24 hours/day for 8 months= 17280 hours. | | | | | | | | | | | |
| Eq Oper, Light | 1920.00 | HR | B-EQOPRLT | 1.00 | 1,920 | 40,280 | 0 | 0 | 0 | 40,280 | 20.98 |
| Deploy & remove 18" polyeth pipe | 3400.00 | LF | CODEX | 25.00 | 680 | 10,912 | 8,432 | 0 | 0 | 19,344 | 5.69 |
| 18"(61cm) Corr Polyethylene Pipe | 3400.00 | LF | | 0.00 | 0 | 0 | 0 | 10,629 | 0 | 10,629 | 3.13 |
| PUMP,CENTRF,DW,12"D,4410G PM/60'H | 5760.00 | HR | P60GF006 | 1.00 | 0 | 0 | 11,878 | 0 | 0 | 11,878 | 2.06 |
| Standby rate | | | | | | | | | | | |
| Dewatering segment | | | | | | | | | | | |
| Assume dewatering two segments totaling 3000' and discharge back to creek, in 1 month, Assume 200' of pipe and accessories | | | | | | | | | | | |
| 12" Goodwin pump, rental cost | 1.00 | MON | | 0.00 | 0 | 0 | 0 | 3,557 | 0 | 3,557 | 3557.40 |
| Quote from Lee Mathews rental, self-priming, diesel powered, skid-mounted, $3,300 month, | | | | | | | | | | | |
| 12" Goodwin pump, O&M costs | 40.00 | HRS | | 0.00 | 0 | 0 | 1,152 | 0 | 0 | 1,152 | 28.80 |
| Eq Oper, Light | 80.00 | HR | B-EQOPRLT | 1.00 | 80 | 1,678 | 0 | 0 | 0 | 1,678 | 20.98 |
| 24"(61cm) Corr Polyethylene Pipe | 200.00 | LF | CODEX | 25.00 | 40 | 642 | 496 | 2,372 | 0 | 3,510 | 17.55 |
| Creek diversion | 3400.00 | LF | | | 2,720 | 53,513 | 254,317 | 16,558 | 0 | 324,388 | 95.41 |

| Excavate,haul,place in cha | QUANTY | UOM | CREW ID | OUTPUT | MANHOUR | LABOR | EQUIPMNT | MATERIAL | QUOTE | TOTAL COST | UNIT COST |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Excavate, haul, place in channel | | | | | | | | | | | |
| Excavate,haul,place in channel | | | | | | | | | | | |
| Excavate and load quantity includes 10% for swell, pricing from Diversion alternative, excavation is with a link belt 1.5 c.y. excavator. | 4070.00 | CY | | 0.00 | 0 | 0 | 0 | 0 | 22,100 | 22,100 | 5.43 |
| Hauling 12 LCY,.80 Miles Material from Dobbs branch and where realignment begins. hauled 4,000' | 3850.00 | CY | COEID | 60.00 | 64 | 1,346 | 2,340 | 0 | 0 | 3,686 | 0.96 |
| Hauling w/ loader and pla cing Priced as a minor item. This is material near Hamel rd. bridge hauled 200' | 220.00 | CY | | 0.00 | 0 | 0 | 0 | 0 | 440 | 440 | 2.00 |
| Place in channel w/ excav ator Priced as a minor item. | 3850.00 | CY | | 0.00 | 0 | 0 | 0 | 0 | 7,700 | 7,700 | 2.00 |
| Excavate, haul, place in | 3700.00 | CY | | | 64 | 1,346 | 2,340 | 0 | 30,240 | 33,926 | 9.17 |

| Realignment excavation | QUANTY | UOM | CREW ID | OUTPUT | MANHOUR | LABOR | EQUIPMNT | MATERIAL | QUOTE | TOTAL COST | UNIT COST |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Realignment excavation | | | | | | | | | | | |
| Realignment excavation | | | | | | | | | | | |
| Excavate, load, haul 2500 ', dump quantity includes 10% for swell, | 101640 | CY | | 0.00 | 0 | 0 | 0 | 0 | 508,200 | 508,200 | 5.00 |
| Excavate with scraper, 1,000' haul $2.00/c.y. | | | | | | | | | | | |
| Load from stockpile, $1.00/c.y. | | | | | | | | | | | |
| haul to stockpile, average 2,500' haul, dump $2.00/c.y. | | | | | | | | | | | |
| $5.00/c.y. | | | | | | | | | | | |
| Realignment excavation | 92400 | CY | | | 0 | 0 | 0 | 0 | 508,200 | 508,200 | 5.50 |

07. In-situ stabilization

| | QUANTY | UOM | CREW ID | OUTPUT | MANHOUR | LABOR | EQUIPMNT | MATERIAL | QUOTE | TOTAL COST | UNIT COST |
|---|---|---|---|---|---|---|---|---|---|---|---|
| In-situ stabilization | | | | | | | | | | | |
| Insitu-stabilization | 14200 | CY | N/A | 0.00 | 0 | 0 | 0 | 0 | 1,420,000 | 1,420,000 | 100.00 |
| Unit/price based on project " In-situ solidfication/ stabilization of contaminated soil, Geiger oil site, Charleston, SC" Bid in March 93, escalated to Oct 94. for this project. Includes mobilization/demobilization and demonstration test. | | | | | | | | | | | |
| In-situ stabilization | 14200 | CY | | | 0 | 0 | 0 | 0 | 1,420,000 | 1,420,000 | 100.00 |

08. Slope protection

| | QUANTY | UOM | CREW ID | OUTPUT | MANHOUR | LABOR | EQUIPMNT | MATERIAL | QUOTE | TOTAL COST | UNIT COST |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Slope protection | | | | | | | | | | | |
| Slope protection | 12200 | TON | | 0.00 | 1,586 | 33,550 | 19,154 | 144,668 | 0 | 197,372 | 16.18 |
| Quarry run rock placed by crane. | | | | | | | | | | | |
| Slope protection | 12200 | TON | | | 1,586 | 33,550 | 19,154 | 144,668 | 0 | 197,372 | 16.18 |

09. Backfill

| | QUANTY | UOM | CREW ID | OUTPUT | MANHOUR | LABOR | EQUIPMNT | MATERIAL | QUOTE | TOTAL COST | UNIT COST |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Backfill | | | | | | | | | | | |
| Backfill | 101640 | CY | | 0.00 | 0 | 0 | 0 | 0 | 345,576 | 345,576 | 3.40 |
| quantity includes 10% for compaction. | | | | | | | | | | | |
| Load from stockpile, $1.00/c.y. | | | | | | | | | | | |
| haul to old channel, $2.00/c.y. average 2,500' haul | | | | | | | | | | | |
| spread and traffic compact working from within channel, $0.40/c.y. | | | | | | | | | | | |
| total $3.40/c.y. | | | | | | | | | | | |
| Backfill | 92400 | CY | | | 0 | 0 | 0 | 0 | 345,576 | 345,576 | 3.74 |

10. Sampling and Analysis

| | QUANTY | UOM | CREW ID | OUTPUT | MANHOUR | LABOR | EQUIPMNT | MATERIAL | QUOTE | TOTAL COST | UNIT COST |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Sampling and Analysis | | | | | | | | | | | |
| Sampling and analysis | 1.00 | LS | | 0.00 | 0 | 0 | 0 | 0 | 25,500 | 25,500 | 25500.00 |
| assume 15 samples per mile, analysis for PAH'S, pesticides & PCB'S, and semivol's. Price schedule from Gary Olsen. | | | | | | | | | | | |
| Sampling and Analysis | | | | | 0 | 0 | 0 | 0 | 25,500 | 25,500 | |

11. Site Restoration

| | QUANTY | UOM | CREW ID | OUTPUT | MANHOUR | LABOR | EQUIPMNT | MATERIAL | QUOTE | TOTAL COST | UNIT COST |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Site Restoration | | | | | | | | | | | |
| Seeding and Mulching | 12.00 | ACR | | 0.00 | 0 | 0 | 0 | 0 | 24,000 | 24,000 | 2000.00 |
| Haul road area and disturbed area, say 12 acres. Priced as a minor item. | | | | | | | | | | | |
| Site Restoration | | | | | 0 | 0 | 0 | 0 | 24,000 | 24,000 | |
| Feasibility estimate for: | 1.00 | EA | | | 13,419 | 290,079 | 493,792 | 291,471 | 2,490,796 | 3,566,138 | 3566138 |

**ALTERNATIVE 3**

**ON-SITE LANDFILLING**

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Feasibility estimate for:
Treatment option for "On-site
landfill", Tennessee products
site, Operable unit 1,
Chattanooga Creek, TN

Designed By: CENWK
Estimated By: CENWK-ED-C

Prepared By: Tom Zimmerman
Price level date: Oct 1999

Preparation Date: 06/03/99
Effective Date of Pricing: 10/01/99

Sales Tax: 7.80%

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Site Description:

The Tennessee Products Site is located in Chattanooga, TN on an approximate 2.5 mile stretch of the Chattanooga Creek where coal tar material was deposited in the creek and surrounding areas.

Treatment Description:

The work consists of stabilization of 14,200 c.y. of coal tar contaminated sediments prior to landfilling; Installation of an approximate 2 acre on-site landfill including 13,150 c.y. of required excavation and 14,672 c.y. for berm construction; Placement of stabilized material in landfill, 29,280 c.y.; Security fencing, 1,190 l.f.; 2 acres seeding and mulching; Operation and maintenance of the site for a 30 year period.

35% overhead, 8% profit, 1% Bond, 9.9% escalation, from April 95 to Oct 99 from Civil Works Construction Cost Index System (CWCCIS) Sep 1998. No construction or design contingency applied as this was considered in quantity calculation. 2% engineering and design applied.

23% budgetary cost factor applied.

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SUMMARY REPORTS SUMMARY PAGE



DETAILED ESTIMATE DETAIL PAGE



No Backup Reports...

* * * END TABLE OF CONTENTS * * *

** PROJECT OWNER SUMMARY - Bid Item (Rounded to 100's) **

| | | QUANTITY | UOM | CONTRACT | ESCALATN | E&D | BUDGET | TOTAL COST | UNIT COST |
|---|---|---|---|---|---|---|---|---|---|
| 01 | Fencing | 1190.00 | LF | 42,900 | 4,200 | 900 | 11,100 | 59,100 | 49.67 |
| 02 | Stabilization | 14200.00 | CY | 1,405,100 | 139,100 | 30,900 | 362,300 | 1,937,300 | 136.43 |
| 03 | Landfill liner | | | 285,000 | 28,200 | 6,300 | 73,500 | 393,000 | |
| 04 | Landfill cover | | | 248,200 | 24,600 | 5,500 | 64,000 | 342,200 | |
| 05 | Excavation for cell and berm | 1.00 | EA | 58,500 | 5,800 | 1,300 | 15,100 | 80,700 | 80671.28 |
| 06 | Place trted material in landfill | 29280.00 | CY | 109,400 | 10,800 | 2,400 | 28,200 | 150,900 | 5.15 |
| 07 | Seeding and Mulching | 2.00 | ACR | 9,600 | 900 | 200 | 2,500 | 13,200 | 6614.29 |
| 08 | Operation and maintenance | | | 13,400 | 1,300 | 300 | 3,500 | 18,500 | |
| TOTAL | Feasibility estimate for: | 1.00 | EA | 2,172,100 | 215,000 | 47,700 | 560,000 | 2,994,900 | 2994864 |

** PROJECT INDIRECT SUMMARY - Bid Item (Rounded to 100's) **

| | | QUANTITY | UOM | DIRECT | OVERHEAD | PROFIT | BOND | TOTAL COST | UNIT COST |
|---|---|---|---|---|---|---|---|---|---|
| 01 | Fencing | 1190.00 | LF | 29,100 | 10,200 | 3,100 | 400 | 42,900 | 36.02 |
| 02 | Stabilization | 14200.00 | CY | 954,100 | 334,000 | 103,000 | 13,900 | 1,405,100 | 98.95 |
| 03 | Landfill liner | | | 193,600 | 67,700 | 20,900 | 2,800 | 285,000 | |
| 04 | Landfill cover | | | 168,600 | 59,000 | 18,200 | 2,500 | 248,200 | |
| 05 | Excavation for cell and berm | 1.00 | EA | 39,700 | 13,900 | 4,300 | 600 | 58,500 | 58508.10 |
| 06 | Place trted material in landfill | 29280.00 | CY | 74,300 | 26,000 | 8,000 | 1,100 | 109,400 | 3.74 |
| 07 | Seeding and Mulching | 2.00 | ACR | 6,500 | 2,300 | 700 | 100 | 9,600 | 4797.11 |
| 08 | Operation and maintenance | | | 9,100 | 3,200 | 1,000 | 100 | 13,400 | |
| TOTAL | Feasibility estimate for: | 1.00 | EA | 1,475,000 | 516,300 | 159,300 | 21,500 | 2,172,100 | 2172072 |
| | ESCALATION | | | | | | | 215,000 | |
| | SUBTOTAL | | | | | | | 2,387,100 | |
| | E&D 2% | | | | | | | 47,700 | |
| | SUBTOTAL | | | | | | | 2,434,800 | |
| | BUDGET 23% | | | | | | | 560,000 | |
| | TOTAL INCL OWNER COSTS | | | | | | | 2,994,900 | |

** PROJECT DIRECT SUMMARY - Bid Item (Rounded to 100's) **

| | | QUANTITY | UOM | MANHOUR | LABOR | EQUIPMNT | MATERIAL | QUOTE | TOTAL COST | UNIT COST |
|---|---|---|---|---|---|---|---|---|---|---|
| 01 | Fencing | 1190.00 | LF | 400 | 6,500 | 4,900 | 17,700 | 0 | 29,100 | 24.46 |
| 02 | Stabilization | 14200.00 | CY | 0 | 0 | 0 | 0 | 954,100 | 954,100 | 67.19 |
| 03 | Landfill liner | | | 2,500 | 16,900 | 9,700 | 81,000 | 85,900 | 193,600 | |
| 04 | Landfill cover | | | 2,100 | 20,700 | 9,700 | 91,600 | 46,600 | 168,600 | |
| 05 | Excavation for cell and berm | 1.00 | EA | 200 | 3,800 | 15,600 | 5,700 | 14,700 | 39,700 | 39731.70 |
| 06 | Place trted material in landfill | 29280.00 | CY | 600 | 12,500 | 32,500 | 0 | 29,300 | 74,300 | 2.54 |
| 07 | Seeding and Mulching | 2.00 | ACR | 100 | 1,000 | 100 | 3,900 | 1,600 | 6,500 | 3257.62 |
| 08 | Operation and maintenance | | | 0 | 0 | 0 | 0 | 9,100 | 9,100 | |
| TOTAL | Feasibility estimate for: | 1.00 | EA | 5,900 | 61,400 | 72,500 | 199,800 | 1,141,300 | 1,475,000 | 1475011 |

| | |
|---|---|
| OVERHEAD | 516,300 |
| SUBTOTAL | 1,991,300 |
| PROFIT | 159,300 |
| SUBTOTAL | 2,150,600 |
| BOND | 21,500 |
| TOTAL INCL INDIRECTS | 2,172,100 |
| ESCALATION | 215,000 |
| SUBTOTAL | 2,387,100 |
| E&D 2% | 47,700 |
| SUBTOTAL | 2,434,800 |
| BUDGET 23% | 560,000 |
| TOTAL INCL OWNER COSTS | 2,994,900 |

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No errors detected...

* * * END OF ERROR REPORT * * *

| General conditions | QUANTY | UOM | CREW ID | OUTPUT | MANHOUR | LABOR | EQUIPMNT | MATERIAL | QUOTE | TOTAL COST | UNIT COST |
|---|---|---|---|---|---|---|---|---|---|---|---|

General conditions

The %Overhead column of 35% is taken as a percentage of the direct costs and consists of field overhead; home office overhead; supervision, engineering, and office personnel; contractor quality control; pollution insurance; builders risk and public liability insurance; bond; health and safety.

01. Fencing

| | QUANTY | UOM | CREW ID | OUTPUT | MANHOUR | LABOR | EQUIPMNT | MATERIAL | QUOTE | TOTAL COST | UNIT COST |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Fencing | | | | | | | | | | | |
| 12'x 10' Double Galv Steel Gate For 10'(3M) High Fence | 2.00 | EA | ULABN | 0.84 | 10 | 152 | 114 | 447 | 0 | 713 | 356.65 |
| 10'(3M)H Galvanized Fencing 390' x 205' | 1190.00 | LF | ULABN | 11.96 | 398 | 6,368 | 4,774 | 17,254 | 0 | 28,396 | 23.86 |
| Fencing | 1190.00 | LF | | | 407 | 6,520 | 4,888 | 17,701 | 0 | 29,109 | 24.46 |

02. Stabilization

| | QUANTY | UOM | CREW ID | OUTPUT | MANHOUR | LABOR | EQUIPMNT | MATERIAL | QUOTE | TOTAL COST | UNIT COST |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Stabilization | | | | | | | | | | | |
| On site stabilization 550 gallon holding tank; 1.25 c.y. wheeled loader; 12 c.y. dump truck; 5 cy waste mixer; operation labor for process equipment; Portland cement type I, 5,750 ton; Hydrated lime, 2,875 ton; Maintenance of system. Price source is RACER (Remedial Action Cost Engineering and Requirements) system. | 14200 | CY | N/A | 0.00 | 0 | 0 | 0 | 0 | 954,145 | 954,145 | 67.19 |
| Stabilization | 14200 | CY | | | 0 | 0 | 0 | 0 | 954,145 | 954,145 | 67.19 |

| 40 mil HDPE | QUANTY | UOM | CREW ID | OUTPUT | MANHOUR | LABOR | EQUIPMNT | MATERIAL | QUOTE | TOTAL COST | UNIT COST |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Landfill liner | | | | | | | | | | | |
| 40 mil HDPE | | | | | | | | | | | |
| 40 Mil Hdpe | 75815 | SF | | 0.00 | 758 | 0 | 0 | 0 | 38,666 | 38,666 | 0.51 |
| 370' x 185'= 68,450 s.f. x | | | | | | | | | | | |
| 1.05 for waste= 71,872 s.f. | | | | | | | | | | | |
| | | | | | | | | | | | |
| Budgetary quote, Gundle Lining | | | | | | | | | | | |
| Systems, $0.51/s.f. installed. | | | | | | | | | | | |
| Geonet - leak detection | | | | | | | | | | | |
| Drainage Net - 1/4 In Thi ck Hdpe | 75815 | SF | USKCF | 6250.00 | 99 | 1,425 | 197 | 14,711 | 0 | 16,334 | 0.22 |
| 60 mil HDPE | | | | | | | | | | | |
| 60 Mil Hdpe | 81430 | SF | | 0.00 | 814 | 0 | 0 | 0 | 47,229 | 47,229 | 0.58 |
| Budgetary quote, Gundel Lining | | | | | | | | | | | |
| Systems, $.58/s.f. installed. | | | | | | | | | | | |
| Geonet - leachate collection | | | | | | | | | | | |
| Drainage Net - 1/4 In Thi ck Hdpe | 81430 | SF | USKCF | 6250.00 | 106 | 1,531 | 212 | 15,801 | 0 | 17,543 | 0.22 |
| 6 oz. geotextile | | | | | | | | | | | |
| Geotextile Fabric, 170 Mi l Thick | 9048.00 | SY | ULABJ | 112.50 | 242 | 3,461 | 267 | 17,557 | 0 | 21,285 | 2.35 |
| Non-Woven Polypropylene | | | | | | | | | | | |
| 6-inch sand protective layer | | | | | | | | | | | |
| Furn & Pl sand layer, 6"D p | 480.00 | CY | CODLA | 11.50 | 63 | 1,278 | 1,284 | 4,916 | 0 | 7,477 | 15.58 |
| Place 3 ft low perm clay (3308050208) | | | | | | | | | | | |
| 7430 c.y. | | | | | | | | | | | |
| Laborer (Semi-Skilled) | 37.15 | HR | B-LABORER | 1.00 | 37 | 527 | 0 | 0 | 0 | 527 | 14.18 |
| Eq Oper, Medium | 37.15 | HR | B-EQOPRMED | 1.00 | 37 | 856 | 0 | 0 | 0 | 856 | 23.03 |
| GRADER,MOTOR,CAT12-G, ART IC | 37.15 | HR | G15CA003 | 1.00 | 0 | 0 | 1,227 | 0 | 0 | 1,227 | 33.04 |
| ARTICULATED FRAME, POWERSHIFT | | | | | | | | | | | |
| CLAY BORROW [CONFIRM PRICE] | 7430.00 | CY | | 0.00 | 0 | 0 | 0 | 28,033 | 0 | 28,033 | 3.77 |
| DELIVERED | | | | | | | | | | | |
| Foreman | 37.15 | HR | B-FOREMAN | 1.00 | 37 | 910 | 0 | 0 | 0 | 910 | 24.49 |
| Cmpt 3 ft low perm clay (3308050209) | | | | | | | | | | | |
| Eq Oper, Medium | 148.60 | HR | B-EQOPRMED | 1.00 | 149 | 3,496 | 0 | 0 | 0 | 3,496 | 23.53 |
| ROLLR,STATIC,S/P,13T,68"W , 9TIRE | 148.60 | HR | R30BO001 | 1.00 | 0 | 0 | 1,980 | 0 | 0 | 1,980 | 13.33 |
| Truck Drivers, Heavy | 74.30 | HR | B-TRKDVRHV | 1.00 | 74 | 1,595 | 0 | 0 | 0 | 1,595 | 21.47 |
| TRK,WTR,OFF-HWY, 6000GAL, CAT621E | 74.30 | HR | T60KI002 | 1.00 | 0 | 0 | 4,580 | 0 | 0 | 4,580 | 61.65 |
| 6,000 GALLON,WITH CAT 621E TRAC | | | | | | | | | | | |
| Foreman | 74.30 | HR | B-FOREMAN | 1.00 | 74 | 1,820 | 0 | 0 | 0 | 1,820 | 24.49 |
| Landfill liner | | | | | 2,490 | 16,898 | 9,748 | 81,018 | 85,895 | 193,559 | |

04. Landfill cover

| Geosynthetic clay layer | QUANTY | UOM | CREW ID | OUTPUT | MANHOUR | LABOR | EQUIPMNT | MATERIAL | QUOTE | TOTAL COST | UNIT COST |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Landfill cover | | | | | | | | | | | |
| Geosynthetic clay layer | | | | | | | | | | | |
| 1/4 In Thick Geocompsite Installed On Polymeric Base<br><br>Unit/price reduced by 50% based on information from Ft. Benning VECP proposal, Jan 1995. | 81700 | SF | USKCF | 900.00 | 727 | 10,686 | 1,503 | 35,229 | 0 | 47,419 | 0.58 |
| 40 mil LLDPE | | | | | | | | | | | |
| 40 Mil lldpe<br>Budetary Quote, Gundle Lining Systems, $0.57/s.f. installed, 2/27/95 | 81700 | SF | | 0.00 | 817 | 0 | 0 | 0 | 46,569 | 46,569 | 0.57 |
| Geonet - drainage layer | | | | | | | | | | | |
| Drainage Net - 1/4 In Thick Hdpe | 81700 | SF | USKCF | 6250.00 | 106 | 1,536 | 212 | 15,853 | 0 | 17,601 | 0.22 |
| 6oz. geotextile | | | | | | | | | | | |
| Geotextile Fabric, 170 Mil Thick Non-Woven Polypropylene | 9078.00 | SY | ULABJ | 112.50 | 242 | 3,472 | 268 | 17,615 | 0 | 21,355 | 2.35 |
| 18-inch common fill | | | | | | | | | | | |
| Exc & Fill, D-9H Dozer w/ U-Blade 410 HP, Move 150' and Stockpile | 4540.00 | CY | CODTN | 135.75 | 42 | 967 | 3,690 | 0 | 0 | 4,657 | 1.03 |
| 6-inch topsoil | | | | | | | | | | | |
| Furn & Pl Imported Topsoil, 6"Dp | 1515.00 | CY | CODLA | 11.50 | 198 | 4,034 | 4,052 | 22,864 | 0 | 30,949 | 20.43 |
| Landfill cover | | | | | 2,132 | 20,695 | 9,725 | 91,561 | 46,569 | 168,550 | |

05. Excavation for cell and berm

| Excavation | QUANTY | UOM | CREW ID | OUTPUT | MANHOUR | LABOR | EQUIPMNT | MATERIAL | QUOTE | TOTAL COST | UNIT COST |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Excavation for cell and berm | | | | | | | | | | | |
| Excavation | | | | | | | | | | | |
| Excavate and haul 200' D-8,300 HP, Move 200' and Stockpile | 13150 | CY | CODTK | 100.00 | 164 | 3,802 | 15,599 | 0 | 0 | 19,400 | 1.48 |
| Berm construction | | | | | | | | | | | |
| Place and compact in berm D-8, 300 HP | 14672 | CY | | 0.00 | 0 | 0 | 0 | 0 | 14,672 | 14,672 | 1.00 |
| CLAY BORROW [CONFIRM PRICE] DELIVERED | 1500.00 | CY | | 0.00 | 0 | 0 | 0 | 5,660 | 0 | 5,660 | 3.77 |
| Excavation for cell and b | 1.00 | EA | | | 164 | 3,802 | 15,599 | 5,660 | 14,672 | 39,732 | 39731.70 |

06. Place trted material in landfill

| Load, haul 500', dump | QUANTY | UOM | CREW ID | OUTPUT | MANHOUR | LABOR | EQUIPMNT | MATERIAL | QUOTE | TOTAL COST | UNIT COST |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Place trted material in landfill | | | | | | | | | | | |
| Load, haul 500', dump | | | | | | | | | | | |
| Exc & Ld,3-1/2CY Wh Ldr,M ed Matl 103 CY/Hr (99M3) | 29280 | CY | CODLI | 130.00 | 337 | 6,895 | 12,558 | 0 | 0 | 19,454 | 0.66 |
| Haul, 26CY, Off Hwy Trk (201M3) @ 20 MPH (30 Km/Hr) (30 Km/Hr) 4.2 Cycles/Hr | 29280 | CY | COETK | 109.00 | 269 | 5,633 | 19,934 | 0 | 0 | 25,567 | 0.87 |
| Spread and traffic compact | | | | | | | | | | | |
| Spread and traffic compac t D-8, 300 HP | 29280 | CY | | 0.00 | 0 | 0 | 0 | 0 | 29,280 | 29,280 | 1.00 |
| Place trted material in l | 29280 | CY | | | 606 | 12,529 | 32,492 | 0 | 29,280 | 74,301 | 2.54 |

07. Seeding and Mulching

| | QUANTY | UOM | CREW ID | OUTPUT | MANHOUR | LABOR | EQUIPMNT | MATERIAL | QUOTE | TOTAL COST | UNIT COST |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Seeding and Mulching | | | | | | | | | | | |
| Mechanical Seeding, 450#/ Acre | 2.00 | ACR | ULABE | 0.04 | 67 | 952 | 83 | 3,881 | 0 | 4,915 | 2457.62 |
| Mulch, hay | 2.00 | AC | | 0.00 | 0 | 0 | 0 | 0 | 1,600 | 1,600 | 800.00 |
| Seeding and Mulching | 2.00 | ACR | | | 67 | 952 | 83 | 3,881 | 1,600 | 6,515 | 3257.62 |

08. Operation and maintenance

| | QUANTY | UOM | CREW ID | OUTPUT | MANHOUR | LABOR | EQUIPMNT | MATERIAL | QUOTE | TOTAL COST | UNIT COST |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Operation and maintenance | | | | | | | | | | | |
| Operation and maintenance | 1.00 | LS | | 0.00 | 0 | 0 | 0 | 0 | 9,100 | 9,100 | 9100.00 |
| $9,100 is a present worth value for an O&M cost of $34,000 for a period of 30 years. Consists of bi-annual mowing. | | | | | | | | | | | |
| Operation and maintenance | | | | | 0 | 0 | 0 | 0 | 9,100 | 9,100 | |
| Feasibility estimate for: | 1.00 | EA | | | 5,866 | 61,396 | 72,534 | 199,820 | 1,141,261 | 1,475,011 | 1475011 |

# ALTERNATIVE 4

# OFF-SITE WASTE-TO-FUEL

Feasibility estimate for:
"Off-site waste to fuel
recycling option", Tn products
site, Operable unit 1,
Chattanooga Creek, TN

Designed By: CENWK
Estimated By: CENW-ED-C

Prepared By: Tom Zimmerman
Price level date: Oct 1999

Preparation Date: 07/01/99
Effective Date of Pricing: 10/01/99

Sales Tax: 7.80%

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Site Description:

The Tennessee Products Site is located in Chattanooga, TN on an approximate 2.5 mile stretch of the Chattanaooga Creek where coal tar material was deposited in the creek and surrounding areas.

Treatment Description:

The work consists transportation and disposal of 14,200 c.y.(19,170 ton) of coal tar deposits/contaminated sediments to an off-site waste to fuel recycling facility.

10% prime contractor G&A applied, 8% profit applied. Pricing is based on historical records for waste to fuel recycling for this project in 1997 and 1998. 2% escalation applied from Jan 99 to Oct 99.

23% budgetary cost factor applied.

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SUMMARY REPORTS SUMMARY PAGE



DETAILED ESTIMATE DETAIL PAGE



No Backup Reports...

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** PROJECT OWNER SUMMARY - Bid Item (Rounded to 100's) **

| | QUANTITY | UOM | CONTRACT | ESCALATN | E&D | BUDGET | TOTAL COST | UNIT COST |
|---|---|---|---|---|---|---|---|---|
| 10 Off-site waste to fuel recycling | 19170.00 | TON | 3,309,900 | 66,200 | 0 | 776,500 | 4,152,700 | 216.62 |
| TOTAL Feasibility estimate for: | 1.00 | EA | 3,309,900 | 66,200 | 0 | 776,500 | 4,152,700 | 4152658 |

** PROJECT INDIRECT SUMMARY - Bid Item (Rounded to 100's) **

| | QUANTITY | UOM | DIRECT | OVERHEAD | PROFIT | BOND | TOTAL COST | UNIT COST |
|---|---|---|---|---|---|---|---|---|
| 10 Off-site waste to fuel recycling | 19170.00 | TON | 2,758,600 | 275,900 | 242,800 | 32,800 | 3,309,900 | 172.66 |
| TOTAL Feasibility estimate for: | 1.00 | EA | 2,758,600 | 275,900 | 242,800 | 32,800 | 3,309,900 | 3309946 |
| ESCALATION | | | | | | | 66,200 | |
| SUBTOTAL | | | | | | | 3,376,100 | |
| BUDGET 23% | | | | | | | 776,500 | |
| TOTAL INCL OWNER COSTS | | | | | | | 4,152,700 | |

** PROJECT DIRECT SUMMARY - Bid Item (Rounded to 100's) **

| | QUANTITY | UOM | MANHOUR | LABOR | EQUIPMNT | MATERIAL | QUOTE | TOTAL COST | UNIT COST |
|---|---|---|---|---|---|---|---|---|---|
| 10 Off-site waste to fuel recycling | 19170.00 | TON | 0 | 200 | 0 | 17,000 | 2,741,300 | 2,758,600 | 143.90 |
| TOTAL Feasibility estimate for: | 1.00 | EA | 0 | 200 | 0 | 17,000 | 2,741,300 | 2,758,600 | 2758564 |
| OVERHEAD | | | | | | | | 275,900 | |
| SUBTOTAL | | | | | | | | 3,034,400 | |
| PROFIT | | | | | | | | 242,800 | |
| SUBTOTAL | | | | | | | | 3,277,200 | |
| BOND | | | | | | | | 32,800 | |
| TOTAL INCL INDIRECTS | | | | | | | | 3,309,900 | |
| ESCALATION | | | | | | | | 66,200 | |
| SUBTOTAL | | | | | | | | 3,376,100 | |
| BUDGET 23% | | | | | | | | 776,500 | |
| TOTAL INCL OWNER COSTS | | | | | | | | 4,152,700 | |

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No errors detected...

* * * END OF ERROR REPORT * * *

| Sampling and Analysis | QUANTY | UOM | CREW ID | OUTPUT | MANHOUR | LABOR | EQUIPMNT | MATERIAL | QUOTE | TOTAL COST | UNIT COST |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Off-site waste to fuel recycling | | | | | | | | | | | |
| Sampling and Analysis | | | | | | | | | | | |
| Labor to sample | | | | | | | | | | | |
| Sampling technician | 16.00 | HR | B-LABORER | 1.00 | 16 | 227 | 0 | 0 | 0 | 227 | 14.18 |
| Labor to sample | 1.00 | EA | | | 16 | 227 | 0 | 0 | 0 | 227 | 226.84 |
| Laboratory Chemical Analysis | | | | | | | | | | | |
| Volatile Organic Analysis (8240) Use 13 samples based on analysis of final report from IT Corporation. | 13.00 | EA | N/A | 0.00 | 0 | 0 | 0 | 3,644 | 0 | 3,644 | 280.28 |
| Semivolatile Organics (8270) | 13.00 | EA | N/A | 0.00 | 0 | 0 | 0 | 7,147 | 0 | 7,147 | 549.78 |
| Pesticides/PCBs (8080) | 13.00 | EA | N/A | 0.00 | 0 | 0 | 0 | 2,943 | 0 | 2,943 | 226.38 |
| TAL Metals (6010/7000s) | 13.00 | EA | N/A | 0.00 | 0 | 0 | 0 | 3,293 | 0 | 3,293 | 253.33 |
| Laboratory Chemical Analy | 1.00 | EA | | | 0 | 0 | 0 | 17,027 | 0 | 17,027 | 17027.01 |

| Process,transportation& Di | QUANTY | UOM | CREW ID | OUTPUT | MANHOUR | LABOR | EQUIPMNT | MATERIAL | QUOTE | TOTAL COST | UNIT COST |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Process,transportation& Disposal | | | | | | | | | | | |
| HAZARDOUS SOLID BULK WASTE, Based on historical records from an earlier phase of this project, Kiplin Industry, Birmingham, Al. $130/ton for processing, transportation and disposal. Say $143/ton to allow for additional processing that may be required to increase the BTU value in the Dobbs area. | 19170 | TON | N/A | 0.00 | 0 | 0 | 0 | 0 | 2,741,310 | 2,741,310 | 143.00 |
| Off-site waste to fuel re | 19170 | TON | | | 16 | 227 | 0 | 17,027 | 2,741,310 | 2,758,564 | 143.90 |
| Feasibility estimate for: | 1.00 | EA | | | 16 | 227 | 0 | 17,027 | 2,741,310 | 2,758,564 | 2758564 |

# ALTERNATIVE 5

# ON-SITE INCINERATION

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Feasibility estimate for:
Treatment option for " On-site
incineration" , Tennessee
products site, Operable unit 1,
Chattanooga Creek, TN

Designed By: CENWK
Estimated By: CENWK-ED-C

Prepared By: Tom Zimmerman
Price level date: Oct 1999

Preparation Date: 06/03/99
Effective Date of Pricing: 10/01/99

Sales Tax: 7.80%

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Site Description:

The Tennessee Products Site is located in Chattanooga, TN on an approximate 2.5 mile stretch of the Chattanooga Creek where coal tar material was deposited in the creek and surrounding areas.

Treatment Description:

The work to be performed consists of on-site incineration of 19,170 tons of waste; Sampling and analysis; Stabilization of treated material failing TCLP, 1,420 c.y.; Backfill treated material in Tennessee products site area with 2 foot of topsoil cover; Site restoration consisting of seeding and mulching.

25% overhead, 8% profit, 1% bond and 9.9% escalation applied.

Design contingency and construction contingency not applied as it was considered in calculating quantities.

2% engineering and design applied. 23% budgetary cost factor applied.

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** PROJECT OWNER SUMMARY - Bid Item (Rounded to 100's) **

| | | QUANTITY | UOM | CONTRACT | ESCALATN | E&D | BUDGET | TOTAL COST | UNIT COST |
|---|---|---|---|---|---|---|---|---|---|
| 01 | Incineration | 19170.00 | TON | 5,178,000 | 512,600 | 113,800 | 1,335,000 | 7,139,500 | 372.43 |
| 02 | Sampling and analysis | 1.00 | EA | 589,100 | 58,300 | 12,900 | 151,900 | 812,200 | 812185.32 |
| 03 | Stabilization and disposal | 1420.00 | CY | 367,200 | 36,300 | 8,100 | 94,700 | 506,200 | 356.51 |
| 04 | Place treated material in cell | 12780.00 | CY | 26,400 | 2,600 | 600 | 6,800 | 36,500 | 2.85 |
| 05 | Imported topsoil cover, 2' | 8067.00 | CY | 231,100 | 22,900 | 5,100 | 59,600 | 318,700 | 39.50 |
| 06 | Site Restoration | 3.00 | ACR | 8,400 | 800 | 200 | 2,200 | 11,600 | 3867.55 |
| TOTAL | Feasibility estimate for: | 1.00 | EA | 6,400,200 | 633,600 | 140,700 | 1,650,100 | 8,824,700 | 8824672 |

** PROJECT INDIRECT SUMMARY - Bid Item (Rounded to 100's) **

| | | QUANTITY | UOM | DIRECT | OVERHEAD | PROFIT | BOND | TOTAL COST | UNIT COST |
|---|---|---|---|---|---|---|---|---|---|
| 01 | Incineration | 19170.00 | TON | 3,692,000 | 923,000 | 461,500 | 101,500 | 5,178,000 | 270.11 |
| 02 | Sampling and analysis | 1.00 | EA | 420,000 | 105,000 | 52,500 | 11,600 | 589,100 | 589050.00 |
| 03 | Stabilization and disposal | 1420.00 | CY | 261,800 | 65,400 | 32,700 | 7,200 | 367,200 | 258.56 |
| 04 | Place treated material in cell | 12780.00 | CY | 18,900 | 4,700 | 2,400 | 500 | 26,400 | 2.07 |
| 05 | Imported topsoil cover, 2' | 8067.00 | CY | 164,800 | 41,200 | 20,600 | 4,500 | 231,100 | 28.65 |
| 06 | Site Restoration | 3.00 | ACR | 6,000 | 1,500 | 800 | 200 | 8,400 | 2805.00 |
| TOTAL | Feasibility estimate for: | 1.00 | EA | 4,563,400 | 1,140,900 | 570,400 | 125,500 | 6,400,200 | 6400230 |
| | ESCALATION | | | | | | | 633,600 | |
| | SUBTOTAL | | | | | | | 7,033,900 | |
| | E&D 2% | | | | | | | 140,700 | |
| | SUBTOTAL | | | | | | | 7,174,500 | |
| | BUDGET 23% | | | | | | | 1,650,100 | |
| | TOTAL INCL OWNER COSTS | | | | | | | 8,824,700 | |

** PROJECT DIRECT SUMMARY - Bid Item (Rounded to 100's) **

| | | QUANTITY | UOM | MANHOUR | LABOR | EQUIPMNT | MATERIAL | QUOTE | TOTAL COST | UNIT COST |
|---|---|---|---|---|---|---|---|---|---|---|
| 01 | Incineration | 19170.00 | TON | 0 | 0 | 0 | 0 | 3,692,000 | 3,692,000 | 192.59 |
| 02 | Sampling and analysis | 1.00 | EA | 0 | 0 | 0 | 0 | 420,000 | 420,000 | 420000.00 |
| 03 | Stabilization and disposal | 1420.00 | CY | 0 | 0 | 0 | 183,700 | 78,100 | 261,800 | 184.36 |
| 04 | Place treated material in cell | 12780.00 | CY | 200 | 3,700 | 15,200 | 0 | 0 | 18,900 | 1.48 |
| 05 | Imported topsoil cover, 2' | 8067.00 | CY | 1,100 | 21,500 | 21,600 | 121,700 | 0 | 164,800 | 20.43 |
| 06 | Site Restoration | 3.00 | ACR | 0 | 0 | 0 | 0 | 6,000 | 6,000 | 2000.00 |
| TOTAL | Feasibility estimate for: | 1.00 | EA | 1,200 | 25,200 | 36,700 | 305,400 | 4,196,100 | 4,563,400 | 4563444 |

| | |
|---|---|
| OVERHEAD | 1,140,900 |
| SUBTOTAL | 5,704,300 |
| PROFIT | 570,400 |
| SUBTOTAL | 6,274,700 |
| BOND | 125,500 |
| TOTAL INCL INDIRECTS | 6,400,200 |
| ESCALATION | 633,600 |
| SUBTOTAL | 7,033,900 |
| E&D 2% | 140,700 |
| SUBTOTAL | 7,174,500 |
| BUDGET 23% | 1,650,100 |
| TOTAL INCL OWNER COSTS | 8,824,700 |

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No errors detected...

* * * END OF ERROR REPORT * * *

Project Distributed Costs

| General conditions | QUANTY | UOM | CREW ID | OUTPUT | MANHOUR | LABOR | EQUIPMNT | MATERIAL | QUOTE | TOTAL COST | UNIT COST |
|---|---|---|---|---|---|---|---|---|---|---|---|

General conditions

The %Overhead column of 25% is taken as a percentage of the direct costs and consists of field office overhead; home office overhead; supervision, engineering, and office personnel; contractor quality control; pollution insurance; builders risk and public liability insurance; bond; health and safety.

01. Incineration

| | QUANTY | UOM | CREW ID | OUTPUT | MANHOUR | LABOR | EQUIPMNT | MATERIAL | QUOTE | TOTAL COST | UNIT COST |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Incineration | | | | | | | | | | | |
| ROTARY KILN INCINERATION OF SLUDGES/SOLIDS | 18460 | TON | N/A | 0.00 | 0 | 0 | 0 | 0 | 3,692,000 | 3,692,000 | 200.00 |
| Includes mobilization and demobilization charge; Unit/price based on information from from Weston, Inc for the "DeRewal Chemical site, feasibility report, Kingwood Township, NJ," $200/ton direct cost. | | | | | | | | | | | |
| Sampling and analysis | | | | | | | | | | | |
| Sampling and analysis | 1.00 | LS | N/A | 0.00 | 0 | 0 | 0 | 0 | 420,000 | 420,000 | 420000.00 |
| includes process feed, process effluent, process ash, aqueous, and confirmatory samples; trial burn/stack test. Price schedule provided by Gary Olsen. | | | | | | | | | | | |
| Stabilization and disposal | | | | | | | | | | | |
| PORTLAND CEMENT, TYPE I, (43 KG) BAG, FOB PLANT | 1420.00 | CY | N/A | 0.00 | 0 | 0 | 0 | 0 | 78,100 | 78,100 | 55.00 |
| 10% of treated material. Price source is RACER system. | | | | | | | | | | | |
| NON-HAZARDOUS SOLID BULK WASTE, | 2840.00 | TON | N/A | 0.00 | 0 | 0 | 0 | 183,691 | 0 | 183,691 | 64.68 |
| assume Qty doubles after stabilization process, includes transportation to sanitary landfill. Price based on Means 99 020 880 2050. | | | | | | | | | | | |
| Place treated material in cell | | | | | | | | | | | |
| Exc & Fill, D-8K Dozer w/ U-Blade | 12780 | CY | CODTK | 100.00 | 160 | 3,695 | 15,160 | 0 | 0 | 18,854 | 1.48 |
| 300 HP, Move 150' and Spread and traffic compact in cell. | | | | | | | | | | | |
| Imported topsoil cover, 2' | | | | | | | | | | | |
| Furn & Pl Imported Topsoil | 8067.00 | CY | CODLA | 11.50 | 1,052 | 21,478 | 21,574 | 121,747 | 0 | 164,798 | 20.43 |
| Assume 330' x 330' cell x 2' of cover. | | | | | | | | | | | |
| Site Restoration | | | | | | | | | | | |
| Seeding and Mulching | 3.00 | ACR | | 0.00 | 0 | 0 | 0 | 0 | 6,000 | 6,000 | 2000.00 |
| Priced as a minor item. | | | | | | | | | | | |
| Feasibility estimate for: | 1.00 | EA | | | 1,212 | 25,172 | 36,733 | 305,438 | 4,196,100 | 4,563,444 | 4563444 |

# ALTERNATIVE 6

# ON-SITE THERMAL DESORPTION

# (INDIRECT FIRED)

---

Feasibility estimate for:
Treatment option of "Indirect
Fired Low Temperature Thermal"
Desorption"Tennessee products
site OU1 Chattanooga Creek, TN

Designed By: CENWK
Estimated By: CENWK-ED-C

Prepared By: Tom Zimmerman
Price level date: Oct 1999

Preparation Date: 07/01/99
Effective Date of Pricing: 10/01/99

Sales Tax: 7.80%

---

Site Description:

The Tennessee Products Site is located in Chattanooga, TN on an approximate 2.5 mile stretch of the Chattanooga Creek where coal tar material was deposited in the creek and surounding areas.

Treatment Description:

The treatment consists of On-site indirect fired low thermal desorption of 19,170 ton of material; Sampling and analysis; Stabilization of material that failed TCLP testing susequent to the thermal treatment, 10% of treated volume 1,420 c.y., disposal of stabilized material in sanitary landfill; Placement of treated material 12,780 c.y. in Tennessee products site area with 2' topsoil cover; Site restoration consisting of seeding and mulching.

25% overhead, 8% profit, 1% bond, 2% escalation applied.

2% engineering and design applied. 23% budgetary cost factor applied made up of 15% bid contingency, 6% construction management and 2% engineering during construction and lab QA.

Design and construction contingency not applied as they were considered in developing the quantities.

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SUMMARY REPORTS SUMMARY PAGE



DETAILED ESTIMATE DETAIL PAGE



No Backup Reports...

* * * END TABLE OF CONTENTS * * *

** PROJECT OWNER SUMMARY - Bid Item (Rounded to 100's) **

| | | QUANTITY | UOM | CONTRACT | ESCALATN | E&D | BUDGET | TOTAL COST | UNIT COST |
|---|---|---|---|---|---|---|---|---|---|
| 01 | Thermal desorption indirect fird | 19170.00 | TON | 6,182,800 | 123,700 | 126,100 | 1,479,500 | 7,912,100 | 412.73 |
| 02 | Sampling and analysis | 1.00 | EA | 422,700 | 8,500 | 8,600 | 101,100 | 540,900 | 540906.61 |
| 03 | Stabilization and disposal | 1420.00 | CY | 362,400 | 7,200 | 7,400 | 86,700 | 463,800 | 326.63 |
| 04 | Place treated material in cell | 12780.00 | CY | 25,700 | 500 | 500 | 6,200 | 32,900 | 2.57 |
| 05 | Imported topsoil cover, 2' | 8067.00 | CY | 224,700 | 4,500 | 4,600 | 53,800 | 287,600 | 35.65 |
| 06 | Site Restoration | 3.00 | ACR | 8,200 | 200 | 200 | 2,000 | 10,500 | 3489.72 |
| TOTAL | Feasibility estimate for: | 1.00 | EA | 7,226,500 | 144,500 | 147,400 | 1,729,200 | 9,247,700 | 9247718 |

** PROJECT INDIRECT SUMMARY - Bid Item (Rounded to 100's) **

| | | QUANTITY | UOM | DIRECT | OVERHEAD | PROFIT | BOND | TOTAL COST | UNIT COST |
|---|---|---|---|---|---|---|---|---|---|
| 01 | Thermal desorption indirect fird | 19170.00 | TON | 4,534,500 | 1,133,600 | 453,500 | 61,200 | 6,182,800 | 322.52 |
| 02 | Sampling and analysis | 1.00 | EA | 310,000 | 77,500 | 31,000 | 4,200 | 422,700 | 422685.00 |
| 03 | Stabilization and disposal | 1420.00 | CY | 265,800 | 66,500 | 26,600 | 3,600 | 362,400 | 255.24 |
| 04 | Place treated material in cell | 12780.00 | CY | 18,900 | 4,700 | 1,900 | 300 | 25,700 | 2.01 |
| 05 | Imported topsoil cover, 2' | 8067.00 | CY | 164,800 | 41,200 | 16,500 | 2,200 | 224,700 | 27.85 |
| 06 | Site Restoration | 3.00 | ACR | 6,000 | 1,500 | 600 | 100 | 8,200 | 2727.00 |
| TOTAL | Feasibility estimate for: | 1.00 | EA | 5,300,000 | 1,325,000 | 530,000 | 71,500 | 7,226,500 | 7226519 |

| | |
|---|---|
| ESCALATION | 144,500 |
| SUBTOTAL | 7,371,000 |
| E&D 2% | 147,400 |
| SUBTOTAL | 7,518,500 |
| BUDGET 23% | 1,729,200 |
| TOTAL INCL OWNER COSTS | 9,247,700 |

** PROJECT DIRECT SUMMARY - Bid Item (Rounded to 100's) **

| | | QUANTITY | UOM | MANHOUR | LABOR | EQUIPMNT | MATERIAL | QUOTE | TOTAL COST | UNIT COST |
|---|---|---|---|---|---|---|---|---|---|---|
| 01 | Thermal desorption indirect fird | 19170.00 | TON | 1,700 | 43,200 | 36,200 | 103,500 | 4,351,600 | 4,534,500 | 236.54 |
| 02 | Sampling and analysis | 1.00 | EA | 0 | 0 | 0 | 0 | 310,000 | 310,000 | 310000.00 |
| 03 | Stabilization and disposal | 1420.00 | CY | 0 | 0 | 0 | 0 | 265,800 | 265,800 | 187.19 |
| 04 | Place treated material in cell | 12780.00 | CY | 200 | 3,700 | 15,200 | 0 | 0 | 18,900 | 1.48 |
| 05 | Imported topsoil cover, 2' | 8067.00 | CY | 1,100 | 21,500 | 21,600 | 121,700 | 0 | 164,800 | 20.43 |
| 06 | Site Restoration | 3.00 | ACR | 0 | 0 | 0 | 0 | 6,000 | 6,000 | 2000.00 |
| TOTAL | Feasibility estimate for: | 1.00 | EA | 2,900 | 68,400 | 72,900 | 225,200 | 4,933,400 | 5,300,000 | 5299977 |

| | |
|---|---|
| OVERHEAD | 1,325,000 |
| SUBTOTAL | 6,625,000 |
| PROFIT | 530,000 |
| SUBTOTAL | 7,155,000 |
| BOND | 71,500 |
| TOTAL INCL INDIRECTS | 7,226,500 |
| ESCALATION | 144,500 |
| SUBTOTAL | 7,371,000 |
| E&D 2% | 147,400 |
| SUBTOTAL | 7,518,500 |
| BUDGET 23% | 1,729,200 |
| TOTAL INCL OWNER COSTS | 9,247,700 |

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No errors detected...

* * * END OF ERROR REPORT * * *

| General conditions | QUANTY | UOM | CREW ID | OUTPUT | MANHOUR | LABOR | EQUIPMNT | MATERIAL | QUOTE | TOTAL COST | UNIT COST |
|---|---|---|---|---|---|---|---|---|---|---|---|

General conditions

The Overhead column of 25% is taken as a percentage of the direct costs and consists of field overhead; home office overhead; supervision, engineering, and office personnel; contractor quality control; pollution insurance; builder's risk and public liability insurance; bond; health and safety.

| | QUANTY | UOM | CREW ID | OUTPUT | MANHOUR | LABOR | EQUIPMNT | MATERIAL | QUOTE | TOTAL COST | UNIT COST |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Thermal desorption indirect fird | | | | | | | | | | | |
| LOW THERMAL DESORPTION SOLIDS<br>Unit/price based on historical, "Industrial Latex Superfund Site Bergen County, NJ" PRAC contract awarded in mid 1998, $180/ton direct cost for Soil Material at effective rate of 9 ton/hour. For this project assume 6 ton/hour effective rate due to the coal tar material. Estimate cost is a direct correlation to throughput, 9/6= 1.5 x $180/ton x 84%(84% is used because the mob/demob cost and permitting would not be affected by a different material)= $227/ton.<br><br>Includes Mob/demob, Permitting the unit, Demonstration test which includes shakedown. An indirect fired unit is assumed as a basis for cost. | 19170 | TON | N/A | 0.00 | 0 | 0 | 0 | 0 | 4,351,590 | 4,351,590 | 227.00 |
| Preparation of material w / dozer<br>120 HP w/Blade,150'Push, for 6 months. Estimate Lime is needed for blending at a rate of 5%. 5% of 19,170 ton= 960 ton at $100/ton delivered= $96,000. $96,000/14,200 c.y.= $6.76/c.y. use $6.76/c.y. material cost for the Lime. | 14200 | CY | XXQNB | 14.79 | 1,680 | 43,243 | 36,197 | 103,479 | 0 | 182,920 | 12.88 |
| Thermal desorption indire | 19170 | TON | | | 1,680 | 43,243 | 36,197 | 103,479 | 4,351,590 | 4,534,510 | 236.54 |

02. Sampling and analysis

| | QUANTY | UOM | CREW ID | OUTPUT | MANHOUR | LABOR | EQUIPMNT | MATERIAL | QUOTE | TOTAL COST | UNIT COST |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Sampling and analysis | | | | | | | | | | | |
| Sampling and analysis includes process feed samples; process effluent samples; process ash samples; aqueous samples; confirmatory samples; trial burn/stack test. Price schedule provided by Gary Olsen. | 1.00 | LS | N/A | 0.00 | 0 | 0 | 0 | 0 | 310,000 | 310,000 | 310000.00 |
| Sampling and analysis | 1.00 | EA | | | 0 | 0 | 0 | 0 | 310,000 | 310,000 | 310000.00 |

03. Stabilization and disposal

| | QUANTY | UOM | CREW ID | OUTPUT | MANHOUR | LABOR | EQUIPMNT | MATERIAL | QUOTE | TOTAL COST | UNIT COST |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Stabilization and disposal | | | | | | | | | | | |
| Stabilization | 1420.00 | CY | N/A | 0.00 | 0 | 0 | 0 | 0 | 95,414 | 95,414 | 67.19 |
| 10% was assumed to fail TCLP for metals and require stabilization, price source from RACER. | | | | | | | | | | | |
| Disposal to sanitary land fill | 2840.00 | TON | N/A | 0.00 | 0 | 0 | 0 | 0 | 170,400 | 170,400 | 60.00 |
| includes transportation, Price based on Means 99 020 880 2050. | | | | | | | | | | | |
| Stabilization and disposa | 1420.00 | CY | | | 0 | 0 | 0 | 0 | 265,814 | 265,814 | 187.19 |

04. Place treated material in cell

| | QUANTY | UOM | CREW ID | OUTPUT | MANHOUR | LABOR | EQUIPMNT | MATERIAL | QUOTE | TOTAL COST | UNIT COST |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Place treated material in cell | | | | | | | | | | | |
| Exc & Fill, D-8K Dozer w/ U-Blade 300 HP, Move 150',spread, and traffic compact. | 12780 | CY | CODTK | 100.00 | 160 | 3,695 | 15,160 | 0 | 0 | 18,854 | 1.48 |
| Place treated material in | 12780 | CY | | | 160 | 3,695 | 15,160 | 0 | 0 | 18,854 | 1.48 |

05. Imported topsoil cover, 2'

| | QUANTY | UOM | CREW ID | OUTPUT | MANHOUR | LABOR | EQUIPMNT | MATERIAL | QUOTE | TOTAL COST | UNIT COST |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Imported topsoil cover, 2' | | | | | | | | | | | |
| Furn & Pl Imported Topsoi l | 8067.00 | CY | CODLA | 11.50 | 1,052 | 21,478 | 21,574 | 121,747 | 0 | 164,798 | 20.43 |
| Assumme 330' x 330' x 2'. | | | | | | | | | | | |
| Imported topsoil cover, 2 | 8067.00 | CY | | | 1,052 | 21,478 | 21,574 | 121,747 | 0 | 164,798 | 20.43 |

06. Site Restoration

| | QUANTY | UOM | CREW ID | OUTPUT | MANHOUR | LABOR | EQUIPMNT | MATERIAL | QUOTE | TOTAL COST | UNIT COST |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Site Restoration | | | | | | | | | | | |
| Seeding and Mulching | 3.00 | ACR | | 0.00 | 0 | 0 | 0 | 0 | 6,000 | 6,000 | 2000.00 |
| Priced as a minor item. | | | | | | | | | | | |
| Site Restoration | 3.00 | ACR | | | 0 | 0 | 0 | 0 | 6,000 | 6,000 | 2000.00 |
| Feasibility estimate for: | 1.00 | EA | | | 2,892 | 68,416 | 72,930 | 225,227 | 4,933,404 | 5,299,977 | 5299977 |

# ALTERNATIVE 6

# ON-SITE THERMAL DESORPTION

# (DIRECT FIRED)

---

Feasibility estimate for:
Treatment option of "Direct
fired Low Temperature Thermal"
Desorption "Tennessee products
site OU 1, Chattanooga Creek, TN

Designed By: CENWK
Estimated By: CENWK-ED-C

Prepared By: Tom Zimmerman
Price level date: Oct 1999

Preparation Date: 07/01/99
Effective Date of Pricing: 10/01/99

Sales Tax: 7.80%

---

Site Description:

The Tennessee Products Site is located in Chattanooga, TN on an approximate 2.5 mile stretch of the Chattanooga Creek where coal tar material was deposited in the creek and surounding areas.

Treatment Description:

The treatment consists of On-site direct fired low thermal desorption of 19,170 ton of material; Sampling and analysis; Stabilization of material that failed TCLP testing susequent to the thermal treatment, 10% of treated volume 1,420 c.y. and disposal in sanitary landfill; Placement of treated material 12,780 c.y. in Tennessee products site area with 2' topsoil cover; Site restoration consisting of seeding and mulching.

40% overhead, 8% profit, 1% bond, 2% escalation applied.

2% engineering and design applied. 23% budgetary cost factor applied made up of 15% bid contingency, 6% construction management and 2% engineering during construction and lab QA.

Design and construction contingency not applied as they were considered in developing the quantities.

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* * * END TABLE OF CONTENTS * * *

** PROJECT OWNER SUMMARY - Bid Item (Rounded to 100's) **

| | | QUANTITY | UOM | CONTRACT | ESCALATN | E&D | BUDGET | TOTAL COST | UNIT COST |
|---|---|---|---|---|---|---|---|---|---|
| 01 | Thermal desorption direct fird | 19170.00 | TON | 3,001,900 | 60,000 | 61,200 | 718,300 | 3,841,500 | 200.39 |
| 02 | Sampling and analysis | 1.00 | EA | 473,400 | 9,500 | 9,700 | 113,300 | 605,800 | 605815.41 |
| 03 | Stabilization and disposal | 1420.00 | CY | 404,500 | 8,100 | 8,300 | 96,800 | 517,600 | 364.52 |
| 04 | Place treated material in cell | 12780.00 | CY | 28,800 | 600 | 600 | 6,900 | 36,800 | 2.88 |
| 05 | Imported topsoil cover, 2' | 8067.00 | CY | 251,700 | 5,000 | 5,100 | 60,200 | 322,100 | 39.92 |
| 06 | Site Restoration | 3.00 | ACR | 9,200 | 200 | 200 | 2,200 | 11,700 | 3908.49 |
| TOTAL | Feasibility estimate for: | 1.00 | EA | 4,169,400 | 83,400 | 85,100 | 997,700 | 5,335,600 | 5335577 |

** PROJECT INDIRECT SUMMARY - Bid Item (Rounded to 100's) **

| | | QUANTITY | UOM | DIRECT | OVERHEAD | PROFIT | BOND | TOTAL COST | UNIT COST |
|---|---|---|---|---|---|---|---|---|---|
| 01 | Thermal desorption direct fird | 19170.00 | TON | 1,965,700 | 786,300 | 220,200 | 29,700 | 3,001,900 | 156.59 |
| 02 | Sampling and analysis | 1.00 | EA | 310,000 | 124,000 | 34,700 | 4,700 | 473,400 | 473407.20 |
| 03 | Stabilization and disposal | 1420.00 | CY | 264,900 | 105,900 | 29,700 | 4,000 | 404,500 | 284.85 |
| 04 | Place treated material in cell | 12780.00 | CY | 18,900 | 7,500 | 2,100 | 300 | 28,800 | 2.25 |
| 05 | Imported topsoil cover, 2' | 8067.00 | CY | 164,800 | 65,900 | 18,500 | 2,500 | 251,700 | 31.20 |
| 06 | Site Restoration | 3.00 | ACR | 6,000 | 2,400 | 700 | 100 | 9,200 | 3054.24 |
| TOTAL | Feasibility estimate for: | 1.00 | EA | 2,730,300 | 1,092,100 | 305,800 | 41,300 | 4,169,400 | 4169423 |

| | |
|---|---|
| ESCALATION | 83,400 |
| SUBTOTAL | 4,252,800 |
| E&D 2% | 85,100 |
| SUBTOTAL | 4,337,900 |
| BUDGET 23% | 997,700 |
| TOTAL INCL OWNER COSTS | 5,335,600 |

** PROJECT DIRECT SUMMARY - Bid Item (Rounded to 100's) **

| | | QUANTITY | UOM | MANHOUR | LABOR | EQUIPMNT | MATERIAL | QUOTE | TOTAL COST | UNIT COST |
|---|---|---|---|---|---|---|---|---|---|---|
| 01 | Thermal desorption direct fird | 19170.00 | TON | 1,700 | 43,200 | 36,200 | 103,500 | 1,782,800 | 1,965,700 | 102.54 |
| 02 | Sampling and analysis | 1.00 | EA | 0 | 0 | 0 | 0 | 310,000 | 310,000 | 310000.00 |
| 03 | Stabilization and disposal | 1420.00 | CY | 0 | 0 | 0 | 0 | 264,900 | 264,900 | 186.53 |
| 04 | Place treated material in cell | 12780.00 | CY | 200 | 3,700 | 15,200 | 0 | 0 | 18,900 | 1.48 |
| 05 | Imported topsoil cover, 2' | 8067.00 | CY | 1,100 | 21,500 | 21,600 | 121,700 | 0 | 164,800 | 20.43 |
| 06 | Site Restoration | 3.00 | ACR | 0 | 0 | 0 | 0 | 6,000 | 6,000 | 2000.00 |
| TOTAL | Feasibility estimate for: | 1.00 | EA | 2,900 | 68,400 | 72,900 | 225,200 | 2,363,700 | 2,730,300 | 2730252 |

| | |
|---|---|
| OVERHEAD | 1,092,100 |
| SUBTOTAL | 3,822,400 |
| PROFIT | 305,800 |
| SUBTOTAL | 4,128,100 |
| BOND | 41,300 |
| TOTAL INCL INDIRECTS | 4,169,400 |
| ESCALATION | 83,400 |
| SUBTOTAL | 4,252,800 |
| E&D 2% | 85,100 |
| SUBTOTAL | 4,337,900 |
| BUDGET 23% | 997,700 |
| TOTAL INCL OWNER COSTS | 5,335,600 |

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No errors detected...

* * * END OF ERROR REPORT * * *

| General conditions | QUANTY | UOM | CREW ID | OUTPUT | MANHOUR | LABOR | EQUIPMNT | MATERIAL | QUOTE | TOTAL COST | UNIT COST |
|---|---|---|---|---|---|---|---|---|---|---|---|

General conditions

The Overhead column of 40% is taken as a percentage of the direct costs and consists of field overhead; home office overhead; supervision, engineering, and office personnel; contractor quality control; pollution insurance; builder's risk and public liability insurance; bond; health and safety.

01. Thermal desorption direct fird

| | QUANTY | UOM | CREW ID | OUTPUT | MANHOUR | LABOR | EQUIPMNT | MATERIAL | QUOTE | TOTAL COST | UNIT COST |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Thermal desorption direct fird | | | | | | | | | | | |
| LOW THERMAL DESORPTION SOLIDS<br>Unit/price based on historical, "GCL Tie and Treating project, Sidney, NY, on-going, NJ" PRAC yet to be definitized $50/ton subcontract cost includes $400,000 for Mob/demob, Permitting the unit, Demonstration test which includes shakedown for soil material. For the coal tar material for this project, use a throughput of 6 ton/hr vs. 14 ton/hr for the soil material. Estimate the cost is a direct correlation to the throughput, 14/6= 2.33 x 80%=(80%is used because mob/demob and demonstration test would not be affected by type of material)x $50/ton = $93.20/ton, use $93/ton. | 19170 | TON | N/A | 0.00 | 0 | 0 | 0 | 0 | 1,782,810 | 1,782,810 | 93.00 |
| Preparation of material w / dozer<br>120 HP w/Blade,150'Push, for 6 months. Includes lime for blending estimate 5%, 5% of 19,170 ton= 960 ton at $100/ton material cost= $96,000. Use $6.76/c.y. for the Lime in the Material column. | 14200 | CY | XXQNB | 14.79 | 1,680 | 43,243 | 36,197 | 103,479 | 0 | 182,920 | 12.88 |
| Thermal desorption direct | 19170 | TON | | | 1,680 | 43,243 | 36,197 | 103,479 | 1,782,810 | 1,965,730 | 102.54 |

02. Sampling and analysis

| | QUANTY | UOM | CREW ID | OUTPUT | MANHOUR | LABOR | EQUIPMNT | MATERIAL | QUOTE | TOTAL COST | UNIT COST |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Sampling and analysis | | | | | | | | | | | |
| Sampling and analysis includes process feed samples; process effluent samples; process ash samples; aqueous samples; confirmatory samples; trial burn/stack test. Price schedule provided by Gary Olsen. | 1.00 | LS | N/A | 0.00 | 0 | 0 | 0 | 0 | 310,000 | 310,000 | 310000.00 |
| Sampling and analysis | 1.00 | EA | | | 0 | 0 | 0 | 0 | 310,000 | 310,000 | 310000.00 |

03. Stabilization and disposal

| | QUANTY | UOM | CREW ID | OUTPUT | MANHOUR | LABOR | EQUIPMNT | MATERIAL | QUOTE | TOTAL COST | UNIT COST |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Stabilization and disposal | | | | | | | | | | | |
| Stabilization<br>10% was assumed to fail TCLP<br>for metals and require<br>stabilization, price source<br>from RACER. | 1420.00 | CY | N/A | 0.00 | 0 | 0 | 0 | 0 | 94,470 | 94,470 | 66.53 |
| Disposal to sanitary land fill<br>includes transportation, Price<br>based on Means 99 020 880 2050. | 2840.00 | TON | N/A | 0.00 | 0 | 0 | 0 | 0 | 170,400 | 170,400 | 60.00 |
| Stabilization and disposa | 1420.00 | CY | | | 0 | 0 | 0 | 0 | 264,870 | 264,870 | 186.53 |

04. Place treated material in cell

| | QUANTY | UOM | CREW ID | OUTPUT | MANHOUR | LABOR | EQUIPMNT | MATERIAL | QUOTE | TOTAL COST | UNIT COST |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Place treated material in cell | | | | | | | | | | | |
| Exc & Fill, D-8K Dozer w/ U-Blade 300 HP, Move 150',spread, and traffic compact. | 12780 | CY | CODTK | 100.00 | 160 | 3,695 | 15,160 | 0 | 0 | 18,854 | 1.48 |
| Place treated material in | 12780 | CY | | | 160 | 3,695 | 15,160 | 0 | 0 | 18,854 | 1.48 |

05. Imported topsoil cover, 2'

| | QUANTY | UOM | CREW ID | OUTPUT | MANHOUR | LABOR | EQUIPMNT | MATERIAL | QUOTE | TOTAL COST | UNIT COST |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Imported topsoil cover, 2' | | | | | | | | | | | |
| Furn & Pl Imported Topsoi l | 8067.00 | CY | CODLA | 11.50 | 1,052 | 21,478 | 21,574 | 121,747 | 0 | 164,798 | 20.43 |
| Assumme 330' x 330' x 2'. | | | | | | | | | | | |
| Imported topsoil cover, 2 | 8067.00 | CY | | | 1,052 | 21,478 | 21,574 | 121,747 | 0 | 164,798 | 20.43 |

06. Site Restoration

| | QUANTY | UOM | CREW ID | OUTPUT | MANHOUR | LABOR | EQUIPMNT | MATERIAL | QUOTE | TOTAL COST | UNIT COST |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Site Restoration | | | | | | | | | | | |
| Seeding and Mulching | 3.00 | ACR | | 0.00 | 0 | 0 | 0 | 0 | 6,000 | 6,000 | 2000.00 |
| Priced as a minor item. | | | | | | | | | | | |
| Site Restoration | 3.00 | ACR | | | 0 | 0 | 0 | 0 | 6,000 | 6,000 | 2000.00 |
| Feasibility estimate for: | 1.00 | EA | | | 2,892 | 68,416 | 72,930 | 225,227 | 2,363,680 | 2,730,252 | 2730252 |